



FAA-E-2444a

November 24, 1975

~~SUPERSEDING FAA-E-2444,~~

8/28/70

AMENDMENT 1, 10/14/71

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

SPECIFICATION

DME GROUND STATION EQUIPMENT, TERMINAL AREA

1. SCOPE

1.1 Scope.- This specification covers requirements for solid state ground station DME (distance measuring equipment) suitable for use in conjunction with terminal area navigation aids. The principal components are transponder, antenna, test, monitor, and control equipments.

2. APPLICABLE DOCUMENTS

2.1 FAA documents.- The following specifications of the issues specified in the invitation for bids or request for proposals, form a part of this specification and are applicable in their entirety except as specifically modified herein.

2.1.1 FAA specifications.-

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| FAA-E-163 | Rack, Cabinet and Open Frame Types |
| FAA-D-2494/1 | Instruction Books. Manuscript Technical: Preparation of Manuscript and System Requirements |
| FAA-D-2494/2 | Instruction Books, Manuscript Technical: Preparation of Manuscript copy and reproducible art work |
| FAA-G-2100/1 | Electronic Equipment, General Requirements; Part 1, Basic Requirements for all Equipment |

FAA-G-2300	Panel and Vertical Chassis, Rack
FAA-E-2248	Transmitter, Localizer
FAA-G-2100/3	Part 3, Requirements for Equipment Employing Semiconductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipments Employing Printed Wiring Techniques
FAA-G-2100/5	Part 5, Requirements for Equipments Employing Micro-electronic Devices

(Copies of this specification and other applicable FAA specifications and drawings may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitation for bids or request for proposals. Requests should fully identify the material desired, i.e., specification and drawing numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the material.)

2.2 Military publications.- The following Military publications, of the issues in effect on the date of the invitation for bids or request for proposals, form a part of this specification and are applicable to the extent specified herein.

2.2.1 Military Standards.-

MIL-STD-470	Maintainability Program Requirements (For Systems and Equipments)
MIL-STD-471	Maintainability Demonstration
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors and Safety
MIL-STD-781	Reliability Tests, Exponential Distribution
MIL-STD-785	Reliability Program for Systems and Equipment, Development and Production

2.2.2 Military Handbook.-

MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment
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(Single copies of Military standards and handbooks may be requested from U. S. Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pa., 19120 (for telephone requests call 215-697-3321, 8 a.m. to 4:30 p.m. (local Philadelphia time) Monday through Friday). Not more than five items may be ordered on a single request; the Invitation for Bids or Contract Number should be cited where applicable. Only latest revisions (complete with the latest amendments) are available. Request all items by document number.

3. REQUIREMENTS

3.1 Equipment to be furnished by the contractor.- Each set of DME ground station equipment shall be complete in accordance with all specification requirements and shall include the items tabulated below and with optional items as specified in the contract schedule. Each set of electronic equipment shall be housed within a single equipment cabinet, (3.3.1) completely wired and ready for operation upon connection of primary power, control, and antenna cables (cables are not required to be furnished under this specification). Each set of equipment shall be tuned and adjusted for operation on a channel assigned in accordance with provisions in the contract schedule. Instruction books in accordance with FAA-D-2494/1 and FAA-D-2494/2 shall be furnished in the quantities specified in the contract schedule.

3.1.1 Basic equipment.- Each DME equipment shall consist of the following:

<u>Component</u>	<u>Quantity</u>	<u>Reference</u>
Transponder	1	3.4
Monitor	1	3.6
Control	1	3.7
Test Unit	1	3.8
Omni-directional antenna	1	3.5.2

3.1.2 Optional equipment.- The Government may, as required by the contract, require the furnishing, of remote status indicator equipment (3.9) or Radio-link synchronized keying equipment (3.10) or both (See 6.3) for use in conjunction with the basic equipment (3.1.1).

3.1.3 Reliability/maintainability.- The contractor shall establish and conduct a reliability/maintainability program in accordance with the requirements of paragraph 3.11. In addition, reliability/maintainability operational tests shall be conducted in accordance with paragraph 4.3. The Government shall select, by means of contract requirements, one of the following two methods for implementing reliability/maintainability for this equipment.

Method 1.- Reliability/maintainability shall be in accordance paragraphs 3.11 and 4.3.

Method 2.- Same as Method 1, less the requirements of paragraph 4.3.1.1.

3.2 Definitions.- The subparagraphs hereto define terminology used in and applicable to equipment furnished under this specification. (See also 1-3.2 of FAA-G-2100/1.)

3.2.1 Nominal values and tolerances.- Throughout this specification, performance requirements are stated in terms of a nominal value and an appended value, in parenthesis, of permissible variation under the

service conditions. Where means of adjustment are provided, it is required that in performance of testing under the service conditions (1-4.12 of FAA-G-2100/1), the parameter be initially adjusted as closely as practicable to the nominal value. In any case, the maximum and minimum values permitted under any conditions are established relative to the specified nominal value.

3.2.2 Interrogation signal.- The term "interrogation signal", as used herein, denotes a signal having the characteristics identified in the subparagraphs hereto.

3.2.2.1 Radio frequency.- The center radio frequency of the interrogation signal is within 0.01% of the interrogation frequency listed in Table 1 for the channel in use.

3.2.2.2 Radio frequency pulse spectrum.- The rf spectrum of the interrogation signal is such that not less than 90% of the energy in each pulse is within a 500 kHz band centered on the channel interrogation signal frequency and in which each additional lobe of the spectrum is of lesser amplitude than the adjacent lobe nearer the channel frequency.

3.2.2.3 RF pulse shape.- The rf envelope of each pulse, as detected by a linear detector, has a shape falling within the limits set forth in the subparagraphs hereto.

3.2.2.3.1 Pulse rise time.- The pulse rise time from the 10 percent point to the 90 percent point of the maximum voltage amplitude on the leading edge of the pulse is not less than 0.2 us (microsecond) nor more than 3.0 us.

3.2.2.3.2 Pulse top.- The instantaneous amplitude of the pulse does not, at any instant between the point on the leading edge which is 95% of the maximum voltage amplitude and the point on the trailing edge which is 95% of the maximum voltage amplitude, fall below a value which is 95% of the maximum voltage amplitude.

3.2.2.3.3 Pulse duration.- The pulse duration, from the 50 percent point of the maximum voltage amplitude on the leading edge of the pulse to the 50 percent point of the maximum voltage amplitude on the trailing edge of the pulse, is 3.5 ± 0.5 us.

3.2.2.3.4 Pulse decay time.- The pulse decay time, from the 90 percent point to the 10 percent point of the maximum voltage amplitude on the trailing edge of the pulse is not less than 0.2 us.

3.2.2.4 Pulse coding.- Pulses are coded in pairs with a spacing, as measured between the 50% maximum voltage amplitude point on the leading edge of the first rf pulse to the corresponding point on the leading edge of the second rf pulse, of (a) 12.0 ± 0.5 us for channel numbers ending in the suffix "X", or (b) 36.0 ± 0.5 us for channel numbers ending in the suffix "Y".

3.2.2.5 Interrogation rate.- The pulse pair rate for each interrogation signal is not less than 20 nor more than 150 pulse pairs per second.

3.2.3 Transponder receiver threshold sensitivity.- Transponder receiver threshold sensitivity is defined as the minimum rf level of interrogation signals required to provide decoded interrogations equal to 70 percent of the number of interrogation pulse pairs.

3.2.4 Transponder reply delay time.- For the purposes of this specification, reply delay time is defined as the time in microseconds of all delay introduced by circuitry of the transponder equipment in transmitting a pair of reply pulses in response to an interrogation signal. The reply delay time is measured from the 50% maximum voltage amplitude point on the leading edge of the first constituent rf pulse of the interrogation pulse pair to the corresponding point on the first constituent rf pulse of the reply pulse pair. Note that first pulse timing is involved which will require retention of the time of the 50 percent amplitude point of the leading edge of the first pulse pending decode or pulse spacing validation.

3.2.5 Operating transponder.- The term "operating transponder", denotes a transponder whose rf output is being radiated by the antenna.

3.2.6 Not used.

3.2.7 Not used.

3.2.8 Fault.- The term "fault", used in conjunction with monitoring, denotes a condition wherein one or more monitored performance characteristics are sensed by a monitor as being outside preselected limits.

3.2.9 Fault threshold.- The term "fault threshold", used in conjunction with monitoring, denotes the point at which a fault is sensed when the performance or signal characteristic monitored deviates from normal.

3.2.10 Alarm.- The term "alarm", used in conjunction with monitoring, denotes a condition in which one or more faults as sensed by monitor equipment have existed for a period of time not less than the time interval provided by the monitor alarm time delay circuitry.

3.2.11 Local control.- The term "local control", denotes control of the transmitter rf output of a transponder through manual operation of a control switch at the DME equipment.

3.2.12 Remote control.- The term "remote control" denotes control of the transmitter rf output of a transponder through dialed control signals from an associated VHF facility.

3.2.13 Antenna gain.- The gain of an antenna at any point in space is defined as the ratio of the power density (watts per square inch)

observed at great distance (free space pattern) at the angular coordinates defining that point when a given amount of rf power is applied to the antenna input terminals, to the power density observed at the same point in space if the identical amount of rf power were applied to the antenna input terminals of a matched, lossless isotropic radiator, such ratio expressed in terms of dB.

3.3 General requirements.- The subparagraphs hereto contain requirements applicable to all equipment items required by contract according to the specification.

3.3.1 Equipment configuration and packaging.- The equipment shall be designed, configured and packaged in such a manner as to facilitate the accomplishment via either front or top access of all test, adjustment, and maintenance operations. All of the electronic equipment components of the basic equipment (3.1.1 less the antenna) and the Radio-link synchronized keying equipment (3.10), when ordered, shall be housed in a single equipment cabinet (3.3.1.1). All unused front panel space shall be covered by blank panels.

3.3.1.1 Equipment cabinet.- The equipment cabinet shall be a cabinet-type rack, accomodating standard 19 inch panel units (drawing D-21140 of FAA-G-2100/1). Screw-type barrier strips shall be provided on one interior side wall for connection of external power and control wiring. The basic equipment cabinet shall conform to either 3.3.1.1.1 or 3.3.1.1.2 below.

3.3.1.1.1 Cabinet rack per FAA-E-163.- The basic equipment cabinet shall be a Type I Cabinet Rack, 76 inch, Rear Door, in accordance with FAA-E-163, with the exception that provisions for rear access and rear door need not be provided, in which case a solid back cabinet shall be provided and adequate ventilation ensured.

3.3.1.1.2 Cabinet rack, optional type.- In lieu of the requirements of 3.3.1.1.1 above, and at the option of the contractor, the basic equipment cabinet shall be a custom-designed or commercially-available cabinet rack equivalent in equipment mounting space, quality of materials, construction methods, and finish to the FAA-E-163 cabinet rack as specified in 3.3.1.1.1, meeting requirements in subparagraphs below.

- (a) References to FAA-E-163 below are for descriptive purposes, as stated.
- (b) The cabinet shall accommodate any combination of standard 19 inch panel units (drawing D-21140) up to a total panel height of 70 inches.
- (c) The maximum height, width, and depth dimensions shall not exceed those of the Type I cabinet rack of FAA-E-163.

- (d) Dimensional and angular tolerances and structural rigidity shall be such that when the full complement of equipment is installed in the cabinet there shall be no interference in the smooth operation of the slide mounted units, including the condition where all units are withdrawn to their full extent. Holes in the bottom or other provisions shall be made for bolting the cabinet to the floor.
- (e) One grounding-type convenience outlet (3.8.10.3 of FAA-E-163) shall be provided and mounted on the front of the cabinet at the bottom.
- (f) The cabinet shall have a bottom opening for cable entrance, and two top square duct openings with closing plates (3.8.13.1, 3.8.13.3, 3.8.13.4, and Fig. 5 of FAA-E-163).
- (g) A cabinet rear door shall not be mandatory. In lieu thereof, a cabinet with front access only may be provided, in which case adequate ventilation shall be maintained.

3.3.1.2 Equipment unit construction.- Each equipment unit shall be a panel chassis unit designed and constructed for sliding into and out of the rack on heavy duty roller type drawer slides. The slides shall be provided with latching stops to limit the travel of the chassis to that sufficient for complete access to the components, and by intentional unlatching of the stops, to permit complete removal of the chassis from the rack. It shall be possible to roll the chassis completely out of the rack without any leads or cables becoming disconnected or damaged or without the necessity of disconnecting any leads to permit full forward travel of the chassis. The leads and cables shall be so positioned that the chassis can be rolled back into the rack without interference with the movement and without damage to the leads and cables. Cable supports or carriers as necessary to meet this requirement shall be provided; however, rubber band or spring type supports shall not be employed.

3.3.1.3 Modular Construction.- Construction with plug-in or easily replaceable sub-assemblies shall be used throughout the equipment in order to provide the specified level of maintainability (3.11.1.b). Modularization shall be based on logical functional block concepts. Design shall be such as to minimize the cost and number of different types of modules required for supply support. Modules shall be printed wiring boards (3.3.6) whenever practical from the standpoint of component size and weight and consistent with circuit performance requirements.

3.3.2 Service conditions.- The ambient conditions (1-3.2.23(b) of FAA-G-2100/1) shall be ENVIRONMENT III for the antenna equipment and ENVIRONMENT II for all other equipment.

3.3.3 Standard design-center values for primary power source.- The equipment shall operate from a single phase AC line power source. The design-center voltage (1-3.2.21 of FAA-G-2100/1) shall be 120 volts.

3.3.4 Duty, test equipment.- For test equipment only, the duty shall be intermittent, attended. (Modifies FAA-G-2100/1 paragraph 1-3.2.23.). When tests are completed, test equipment is turned off, therefor normal operation shall not depend upon test equipment circuits or signals.

3.3.5 Solid state design.- All active electronic devices shall be semiconductor devices in accordance with FAA-G-2100/3 or micro-electronic devices in accordance with FAA-G-2100/5. Tubes shall not be employed.

3.3.6 Printed wiring and printed wiring boards.- Printed wiring, in accordance with FAA-G-2100/4, shall be used wherever such wiring is suitable and practicable. All printed wiring boards shall be of the plug-in card type and shall be mechanically coded and keyed in such a manner that only properly coded boards can be inserted. One printed wiring board extender of each type and size used in the equipment shall be furnished in a suitable storage space within the equipment with each complete set of DME required by contract. For purposes of this specification, stripline devices are classed as printed wiring.

3.3.7 Cross-talk, shielding and isolation.- The arrangement of parts and wiring and the design of the equipment shall be such that cross-talk and unnecessary coupling between circuits cannot result in conditions of operation which are beyond the values allowed for the specified performance characteristics. Adequate shielding and other means of isolation shall be provided as necessary to prevent the occurrence of significant changes in signal levels, waveforms, timing, tuning, or operating conditions with any combination of open access doors or withdrawn chassis or with printed wiring extender boards (3.3.6) in use. Also, the positioning of wires or cables shall not affect the operating conditions or performance of the equipment.

3.3.8 Gain, selectivity and bandpass characteristics.- The replacement of semiconductor devices or micro-electronic devices shall not require retuning or realignment of rf circuitry (for example, IF amplifiers) to obtain gain, selectivity and bandpass characteristics necessary to provide the performance required of the equipment. All performance requirements shall be met when the characteristics of semiconductor devices are anywhere within the upper and lower specification limits for the parts used. Compliance with these requirements shall be demonstrated through substitution.

3.3.9 Characteristics of rf signal couplers.- All rf couplers shall have a minimum directivity of 20 dB. Interrogation signal couplers shall provide a design center path attenuation (including the attenuation of associated fixed cables) of 30.0 dB. Coupling factor accuracy and stability shall be such that, when used with the associated test equipment,

the measurement accuracy requirements of paragraph 3.8.1 are met. Calibration curves of coupling factor versus frequency shall be provided, if required, to meet the above requirements over the DME frequency band.

3.3.10 Front panel monitoring.- Front panel tip jacks shall be provided for monitoring all regulated DC voltages within the transponder, monitor, test and control equipments.

3.3.11 Not used.

3.3.12 Test points and connectors.- Each component of the ground station equipment shall contain test points and connectors, appropriately labeled and numbered, as necessary to provide for the examination of significant voltages, signal amplitudes, waveforms and timing characteristics and to provide for the connection of test equipment for adjustment and maintenance operations. The type of test points and connectors provided shall be compatible with the applications for which the test points and connectors are needed. All test points and connectors shall be accessible with adequate visibility and clearance from adjacent objects to permit safe and unhampered connection of cables and probes. Connection to test points and connectors utilized in either adjusting or testing the DME for proper performance shall not necessitate interrupting operational use of the DME. Test points on plug-in printed wiring boards shall be located on the outside edge of the board.

3.3.13 Parts protection.- When protective devices are adjusted as prescribed by the contractor, the loss of cooling airflow, voltage, or current within the equipment shall not result in damage to any part. Further, no part in the equipment shall be subjected to voltage, current or dissipation in excess of applicable ratings as a result of the adjustment of variable controls. The equipment shall withstand, without operational interruption or malfunction and without damage, a transient increase in the AC line voltage superimposed for as long as 500 milliseconds on the AC line voltage waveform, and reaching a peak voltage which is +200% of the peak value of the design-center AC line voltage. (Modifies first sentence of FAA-G-2100/1, 1-3.3.4).

3.3.14 Crystals and crystal ovens.- All frequency determining crystals shall be plug-in mounted. Use of a crystal oven is not allowed.

3.3.15 Access to controls.- All controls which may require adjustment in the conduct of test, measurement and operations necessary to achieve the performance required shall be accessible on the front of each equipment unit or shall be immediately available from the top of the unit upon withdrawing the sliding chassis.

3.4 Transponder design, functional and performance requirements.- Each transponder equipment when operated in conjunction with the antenna of paragraph 3.5 and an identification keyer, shall:

- (a) produce and radiate international Morse code identification signals in response to the operation of an identification keyer;
- (b) receive and decode interrogation signals and, in response thereto, radiate a properly coded reply pulse pair after a specific reply delay time; and
- (c) produce and radiate randomly distributed pulse pairs, in addition to those of (b) above, sufficient in number to maintain a minimum nominal pulse rate of 1350 pulse pairs per second.

The following paragraphs identify requirements for the transponder equipment and associated circuitry.

3.4.1 Operating channels.- Transponders shall provide the specified performance on each of the channels listed in Table I when the proper frequency determining crystals are installed. Except for installation of the appropriate crystals, no additional equipment changes shall be required for operation on any other Channel assignments, including both "X" and "Y" channels. Each equipment shall be furnished with a complete set of operating crystals (installed) and a duplicate set of spare crystals for operation on the assigned channel.

3.4.1.1 Channel frequency accuracy and stability.- The output radio frequency of the transponder shall be within 0.002 percent of that specified in Table I for the assigned channel, over the service conditions.

3.4.2 Duplexer.- The duplexer shall be of the passive type permitting simultaneous operation of the receiver and transmitter. No adjustment is permitted in order to achieve the performance required throughout the band of frequencies listed in Table I.

3.4.3 Receiver and associated video circuitry.- All performance requirements of paragraph 3.4.3 to 3.4.7.3 which involve DME interrogation signals shall be met when the interrogation signal(s) have any combination of characteristics set forth under paragraph 3.2.2 and, unless otherwise indicated, when the signals occur at levels from the threshold sensitivity level to not less than -10 dBm as referenced to the transponder antenna transmission line connector.

3.4.3.1 Not used.

3.4.3.2 Receiver bandwidth and stability.- The bandwidth of the receiver and the stability thereof shall be such that the threshold sensitivity is not reduced by more than 3 dB when the total receiver drift in either direction is added directly to an interrogation signal frequency deviation of 100 kHz in the opposite direction.

3.4.3.3 Receiver decoder.- The decoder shall decode and produce an output pulse from interrogation signal pulse pairs occurring at spacings within the range of:

- (a) 12 ± 0.5 us for channel numbers ending in the suffix "X" or
- (b) 36 ± 0.5 us for channel numbers ending in the suffix "Y".

Decoding of a single pulse shall not occur.

3.4.3.4 Receiver dead time.- Each decoder output pulse (3.4.3.3) shall result in the generation of a dead time interval during which time the transponder shall not reply to any other signals at any and all levels up to -10 dBm. The dead time interval shall be adjustable throughout the range of 50 to 150 us. With the exception of the number of decoded receiver noise pulses permitted under 3.4.3.10, dead time shall only be generated by received and decoded interrogation pulse pairs.

3.4.3.5 Receiver recovery time.- The recovery time of the receiver and its associated video circuitry shall be such that the threshold, sensitivity to desired interrogations is not reduced by more than 1 dB when desired interrogations occur 8 us and more after the reception of undesired pulses having all levels up to 60 dB above the threshold sensitivity of the receiver in the absence of such undesired pulses. The desired interrogation shall be rf pulse pairs conforming to the characteristics specified in paragraph 3.2.2 et seq and the undesired pulses shall conform to the same requirements except that the pulse spacing shall be outside the limits of 3.2.2.4 (such that dead time is not generated). The 8 us spacing shall be measured between the 50 percent voltage point on the leading edge of the second pulse of the undesired pulse pair and the corresponding point on the leading edge of the first pulse of the desired pulse pair.

3.4.3.6 Echo suppression.- Echo suppression shall be provided in accordance with the following subparagraphs.

3.4.3.6.1 Short distance echoes.- Synchronous pulse signals occurring between the constituent pulses of a direct path interrogation pulse pair and which are also superimposed on the leading or trailing edge of the second pulse of the direct path pulse pair, shall not affect the time of decoding of the direct pulse pair by an amount in excess of 0.15 us. Neither shall the reply efficiency be reduced by more than 10 percentage points from that measured in the absence of the echo pulse. These requirements shall be met when the rf input signal level of the direct path pulse pair has any level from 10 dB above threshold sensitivity level to an absolute level of -10 dBm and the echo pulse has any level up to the level of the direct pulse pair and for all direct pulse pair spacings of 3.4.3.3. (For test purposes, the echo pulse shall have a width of 8 us and need not be rf phase coherent with the direct path interrogation signal).

3.4.3.6.2 Long distance echoes.- A separate echo suppression circuit shall be provided in order to prevent the generation of multiple replies to aircraft interrogations having echoes which are delayed with respect

to the direct path signal in excess of receiver dead time setting. The echo suppressor circuit shall be triggered by the decoding of a direct signal pulse pair whenever the level of the pulses exceeds a pre-established level. Such triggering shall result in the generation of a receiver desensitizing pulse starting at the time of pulse decoding. The amount of receiver desensitization shall be to a level of 3.0 ± 3 dB above the level of the direct path signal and shall hold over the entire duration of the echo suppression pulse, unless retriggered by a signal stronger by 0 to 6 dB than the direct path signal, and over a range of input signals from 10 dB above threshold sensitivity to -15 dBm. Individual controls shall be provided for:

- (a) Adjustment of the triggering level between a level 10 dB above threshold sensitivity to an absolute level in excess of -10 dBm (effectively disabling the echo suppression feature).
- (b) Adjustment of the period of desensitization between 50 and 350 microseconds.

3.4.3.6.2.1 Long distance echo suppression disable.- When the OPERATING MODE switch of paragraph 3.6.3.1 is in the NORMAL position, the long distance echo suppression feature shall be disabled and the receiver returned to its un-desensitized level for the duration of the monitor interrogation pulse pairs. This feature shall be selectable by means of a movable link.

3.4.3.7 Receiver sensitivity.- The threshold sensitivity for a reply efficiency of 70 percent shall be in accordance with the following subparagraphs. The measurements shall be referenced to the exterior cabinet connector to which the transmission line to the antenna is connected.

3.4.3.7.1 On-channel sensitivity.- For interrogation signals having a repetition rate of 30 pulse pairs per second and having spacings of the constituent pulses of a pair equal to the design center values, the threshold sensitivity shall not be less than -79 dBm in the absence of other interrogations (see paragraph 3.4.3.10).

3.4.3.7.1.1 Sensitivity variation with interrogation loading.- With a receiver dead time setting of 60 us, the threshold sensitivity of the receiver shall not be reduced by more than 1 dB when the number of decoded interrogations is increased to as many as 2700 pulse pairs per second (2000 for "Y" channel) with the echo suppression circuit 3.4.3.6.2. disabled.

3.4.3.7.1.2 Sensitivity at other pulse spacings.- Under conditions wherein the spacing of the constituent pulses of a pair vary from the design center value by ± 0.5 us, the threshold sensitivity in the absence of other interrogations shall not be reduced by more than 1 dB. The threshold sensitivity to DME signal pulses having a spacing of the constituent pulse of a pair deviating from the design center value by ± 3.0 us and more shall be reduced by not less than 70 dB.

3.4.3.7.1.3 Desensitization by adjacent channel interrogations.- The presence of interrogation signals at ± 900 kHz from the on-channel frequency which have pulse coding corresponding to that for the on-channel frequency and which occur at rates up to 1000 pulse pairs per second shall not reduce the on-channel threshold sensitivity by more than 1 dB. The requirement shall be met when the adjacent channel signals have levels up to -10 dBm.

3.4.3.7.1.4 Desensitization by CW.- The presence of CW interference signal on the assigned channel frequency or elsewhere within the receiver pass-band shall not reduce the on-channel threshold sensitivity by more than 2 dB when the level of the CW is 10 dB and more below the threshold triggering level in the absence of CW interference. (This requirement shall be met for all settings of the receiver squitter rate control 3.4.3.10 which result in receiver noise decodes at a rate of no greater than 10 per second.) Additionally, within the range of receiver desensitization provided by automatic gain reduction (3.4.3.12) the reply efficiency to a single aircraft interrogation shall not be reduced by more than 10% when the level of the interrogation signal is 6 dB and more above the level of the interfering CW signal.

3.4.3.7.2 Sensitivity to adjacent channel interrogations.- The receiver shall not respond to interrogation signals at frequencies ± 900 kHz removed from the on-channel interrogation frequency and which have spacings of the constituent pulses of a pair at the design center values for the frequency in use at any level up to -10 dBm.

3.4.3.8 Reply efficiency.- In the absence of other interrogations, the receiver and its associated video circuitry shall provide a reply efficiency of not less than 85% (80% for "Y" channel) to the interrogations of a single aircraft (30 pps) when the level of interrogating signal is 10 dB above the threshold sensitivity level. In the presence of additional interrogations of 7670 pps (9070 for "Y" channel) having signal levels above the threshold sensitivity level, the reply efficiency to the same single aircraft interrogation shall not be less than 60% (50% for "Y" channel) with a receiver dead time setting of 60 μ s and with the echo suppression circuit 3.4.3.6.2 disabled. (For purposes of demonstration of compliance the effect the specified number of interrogations may be simulated through the use of one or more generators producing a total of 4800 decodes per second in the absence of other interrogations.)

3.4.3.9 Interference suppression.- The following requirements shall be met when signals at the referenced frequencies are applied to the antenna transmission line connector at the transponder cabinet. Signals at intermediate frequencies shall be suppressed by not less than 80 dB. With the exception of the pass band provided to achieve the performance required for on-channel and adjacent channel interrogation signals and to comply with the requirements of paragraph 3.4.3.2, all other signals within the 960 to 1215 MHz band and at image frequencies shall be suppressed by not less than 75 dB.

3.4.3.10 Random squitter pulses.- The video circuitry associated with the receiver shall include a separate squitter pulse generator. All squitter pulses other than those allowed hereunder to be derived from receiver noise shall be derived from the separate squitter pulse generator. Squitter pulses from the separate squitter pulse generator shall not be decoded by the interrogation signal decoder. Further, squitter pulses from the separate squitter pulse generator shall not prevent the transponder from replying to interrogation signals providing the reply delay in "Y" channel operation is a minimum of 50.0 us. A control(s) shall be provided to permit adjustment of the number of squitter pulses derived from receiver noise.

The on-channel threshold sensitivity requirements of paragraph 3.4.3.7.1 et seq shall be met when the receiver squitter rate control is adjusted to provide decoded receiver noise pulses at a rate no greater than 10 per second. It shall be possible, by setting the receiver gain control to minimum position, to reduce the receiver threshold sensitivity to -60 dBm or lower.

3.4.3.11 Pulse rate control.- The composite signal at the video input terminal of the priority gating circuitry (paragraph 3.4.3.13) shall consist of decoded interrogation pulses or squitter pulses, or both in accordance with the following and paragraph 3.4.3.12. The squitter pulses from the separate squitter generator shall be automatically controlled in number as a function of interrogation signal loading (3.4.3.11.1). The output pulse spacing distribution of the separate squitter generator shall be non-uniform. Under no condition of interrogation signal loading shall spacing within the range of 730 to 750 microseconds be present. Additionally, under no condition of interrogator loading shall pulses spaced less than 60 microseconds apart be present.

3.4.3.11.1 Effect of traffic loading.- For all interrogation rates resulting in zero to 1500 receiver decodes per second, the squitter pulse generator shall produce not more than 1500 $(1-N/1500)$ pulses per second nor less than 1200 $(1-N/1200)$ pulses per second where N is the number of receiver decodes. For all interrogation rates resulting in excess of 1500 receiver decodes per second, the squitter pulse generator shall produce no output.

3.4.3.12 Automatic gain reduction.- Under interrogation overload conditions in which the number of replies to interrogation signals tends to exceed 5000 per second, the receiver sensitivity shall be automatically reduced by the minimum amount necessary to maintain the transponder output pulse rate of 5000 (± 150) pulse pairs per second. The available gain reduction shall be not less than 35 dB.

3.4.3.13 Priority of transmission.- The transmission of transponder output signal pulses shall conform to the following order of precedence:

- (1) identity pulse groups;
- (2) distance reply pulse pairs; and
- (3) squitter pulse pairs.

Neither distance reply nor squitter pulse pairs shall be transmitted during the transmission of identification signal pulse groups. Whenever triggers due to squitters occur prior to triggers due to decodes at the input of the priority gating circuits, the squitter triggers shall be inhibited for all spacings between triggers, of 25 us and less in "X" channel and 10 us and less in "Y" channel. The above operation applies for reply delay settings of 50 us and greater. Whenever triggers due to decodes occur prior to squitter triggers, the squitter triggers will be inhibited for all spacings of 25 us and less for "X" channel and 65 us and less for "Y" channel.

3.4.4 Identification signals and keying.- Each transponder shall include circuitry generating properly timed identification signal pulse groups which are transmitted in accordance with the International Morse Code keying provided by an identification keyer unit in an associated VHF facility. During the transmission interval, the identification signal as transmitted shall consist of two pulse pairs at a regular repetition rate of 1350 (+10) groups per second. The spacing of the constituent pulses of each pair shall conform to the spacing required for the channel in use. The spacing between the first and second (auxiliary) pulse pairs constituting an identification signal pulse group shall be 100 (+10) us. The measurement shall be made between the 50 percent maximum voltage amplitude points on the leading edge of the first pulse of each pair. The capability for removal of the equalizing pulse pairs either through permanent removal of a terminal board jumper or through the action of the control unit shall be provided.(see 3.6.4.1 and 3.7.1.3).

3.4.4.1 Identification keying control circuits.- The transponder shall transmit identification signals when the switching circuitry or contacts of the VHF facility identification keyer are closed. The switching device responding to the closure of identification keyer switching circuitry or contacts shall provide reliable keying when the loop resistance of the control cable conductors has all values up to 350 ohms. The current passing through the identification keyer contacts shall not exceed 25 mA for each transponder nor shall the open circuit voltage across the keyer contacts exceed 50 volts. The switching device used to accomplish the required keying, shall be of a type and quality which will provide a life expectancy of not less than 8 million operations as used in the equipment.

3.4.4.2 Identity keying control switch.- A manually operated switch shall be provided on each transponder for selection of (1) normal identification keying, (2) removal of identification keying, and (3) continuous transmission of identification signal pulse groups. The switch shall function to control the priority gating circuitry of paragraph 3.4.3.13.

3.4.5 Transmitter and associated circuitry.- The subparagraphs hereto identify requirements applicable to the transmitter and its associated modulator circuitry.

3.4.5.1 Tuning and spurious output.- The tuning of all rf stages shall be straightforward and free of ambiguities. There shall be no spurious output or parasitic oscillations in any stage for any combination of tuning control positions with either normal or subnormal excitation conditions.

3.4.5.2 RF output power control.- A front panel control shall be provided to permit continuous adjustment of the rf output power of the transponder throughout a range of 0 to -6 dB relative to power level specified in paragraph 3.4.7.4. All transponder output signal requirements of paragraph 3.4.7 et seq shall be met throughout the specified range of power output levels without the need for readjustment of any other controls.

3.4.5.3 Reply delay time adjustment.- Controls shall be provided to set the nominal reply delay time to within 0.0625 us of any desired value between the limits of 35 to 51 us on "X" channels (46 to 62 us on "Y" channels).

3.4.6 Power control and switching.- Each transponder shall contain all control and switching devices necessary for primary power control, local high voltage control, time delay, and overload control functions, and for remote control as required under paragraph 3.7. (The term "high voltage" as used herein refers to all power supply voltages of the transmitter and modulator except those which are also required for operation of the receiver and its associated video circuits. Removal of high voltage shall cause transmitter output radiation to cease.)

3.4.6.1 Local high voltage control switch.- A manually operated switch shall be provided on the front surface of each transponder to permit local control of the application of high voltage to the transmitter when the Local-Remote switch in the control equipment of paragraph 3.7 is in the Local position only. The application of high voltage shall be subject to the operation of interlock devices (when required under 1-3.5.2 of FAA-G-2100/1) and protective devices. Power shall be applied to a front panel indicator light when high voltage is switched on.

3.4.6.2 Operation of overload protective devices.- Overload protective devices other than fuses and primary power circuit breakers shall be capable of being electrically reset through action of the control equipment of paragraph 3.7.

3.4.7 Transponder output signals.- The transponder shall produce output signals conforming to the requirements of the subparagraphs hereto. The pulse rate and priority for pulse pairs shall conform to the requirements of paragraphs 3.4.3.11 and 3.4.3.13. Throughout the range of direct and indirect path rf input signal levels specified in paragraphs 3.4.3 and 3.4.3.6, the transponder shall not, for all time relationships of indirect path signals occurring within the receiver dead time gate, cause or produce false distance reply pulse pairs.

3.4.7.1 Pulse shape.- The rf envelope of each pulse, as detected by a linear detector, shall have a smoothly rounded shape falling within the following limits.

3.4.7.1.1 Pulse rise time.- The rise time shall be 2.5 (+0.5, -1.0) us.

3.4.7.1.2 Pulse top.- The instantaneous amplitude of the pulse shall not, at any instant between the point on the leading edge which is 95 percent of the maximum voltage amplitude and the point on the trailing edge which is 95 percent of the maximum voltage amplitude, fall below a value which is 95 percent of the maximum voltage amplitude.

3.4.7.1.3 Pulse duration.- The pulse duration shall be 3.5 (+0.5) us.

3.4.7.1.4 Pulse decay time.- The decay time shall be 2.5 (+0.5, -1.0) us.

3.4.7.2 Pulse coding.- Pulses shall be coded in pairs with a spacing, as measured between the 50 percent maximum voltage amplitude point on the leading edge of the first rf pulse to the corresponding point on the leading edge of the second rf pulse, of (a) 12 (+0.25) us for channel numbers ending in the suffix "X" or, (b) 30 (+0.25) us for channel numbers ending in the suffix "Y".

3.4.7.3 RF delay time variation.- Reply delay time variation shall not exceed the following:

(a) +0.25 u sec over the range of service conditions with signal level variation over the range of -10dBm through threshold sensitivity level with an interrogation pulse rise time of 2.5 +0.5 u sec.

(b) +0.15 u sec over the range of service conditions with an input signal level of -60 dBm with an interrogation pulse rise time of 2.5 +0.5 u sec.

(c) A total variation of 0.15 u sec with an input signal level of -60 dBm with variation in interrogation pulse rise time through the range of 0.2 u sec to 2.0 u sec.

3.4.7.4 Transponder power output.- The power output at the peak of each pulse shall not be less than a level of 100 watts as measured at the rf output connector on the transponder cabinet.

3.4.7.5 Pulse power variation.- The difference in power level at the peak of the constituent pulses of any pulse pair shall not exceed 1 dB. Additional amplitude modulation of the output pulse train shall not exceed 5 percent.

3.4.7.6 RF pulse signal spectrum.- The pulse signal spectrum of the transponder output signal shall be such that the power contained in a 0.50 MHz band centered on frequencies 0.80 MHz above and below the nominal reply frequency is in each case at a level which is not less than 37 dB below the power contained in a 0.50 MHz band centered on the nominal reply frequency. The power contained in a 0.50 MHz band centered

on frequencies 2.0 MHz above and below the nominal reply frequency shall in each case be at a level which is not less than 57 dB below the power contained in a 0.50 MHz band centered on the nominal reply frequency. All other like bands of the spectrum which are further removed from the reply frequency shall have lower levels of power therein than the adjacent band nearer the reply frequency. (The above dB ratios shall apply when the transponder is delivering 100 watts of peak power. For any higher peak power output, the minimum dB ratios shall be increased proportionately ... e.g., for an output power of 125 watts the dB ratios shall be 38 and 58 dB in lieu of 37 dB and 57 dB. Conversely, for the reduced power levels specified in paragraph 3.4.5.2, the dB ratios shall be reduced proportionately.)

3.4.7.7 Spurious output.- At all frequencies from 27 to 1660 MHz, but excluding the band of frequencies from 960 to 1215 MHz, the spurious output as measured at the antenna transmission line connector shall not exceed -40 dBm/kHz of receiver bandwidth. For purposes of determining compliance, measurement shall be made using a receiver having a -6 dB bandwidth not greater than 100 kHz.

3.4.7.8 Inter-pulse output level.- The rf output level during the interval between occurrence of the desired pulse pairs shall not exceed a level which is 80 dB below the maximum power level during the pulse. In addition, between the pulses of each pair there shall be an interval of 1.0 microsecond or greater length during which the rf output level does not exceed a level which is 50 dB below the maximum power level of each pulse.

3.4.7.9 Retriggering of transponder.- Pulse energy from a transponder shall not result in retriggering of the transponder.

3.4.8 Stabilization of performance characteristics.- Within 3 seconds after initial application of high voltage to the transmitter final rf amplifier, the peak power output of the transponder shall have reached a level of not less than 90 percent of the steady state level for the same set of service conditions. Further, all other performance characteristics of the transponder shall be within prescribed limits as identified in paragraph 3.4 et seq. These requirements shall be met when high voltage is applied as soon as 5 minutes (modifies FAA-G-2100/1) after initial application of main power to the transponder. As used in this paragraph, the term "set of service conditions" denotes that set of environmental conditions required under FAA-G-2100/1 paragraph 1-4.3.3.2 for steps 3, 6 and 8.

3.4.9 Directional couplers.- A minimum of three (3) directional couplers shall be provided in the transponder output transmission line (ahead of the transponder output jack and in the common path of received and transmitted rf signals), to provide the following functions:

- (a) Monitor interrogation by the signal generator
- (b) Replies to monitor interrogations
- (c) Power measurement

Each coupler shall meet the requirements of 3.3.9 for stability and directivity. Coupler (a) shall have a nominal coupling factor of 30 dB. The coupling factors of (b) and (c) shall be as required for proper operation of the monitor (3.6.4) and the power diode (3.8.2.2) respectively, however, the nominal coupling factor shall not be less than 20 dB.

3.4.10 Duty cycle overload protection.- Means shall be provided to protect equipment components against the effect of excessively high transponder output pulse rates caused by malfunction of squitter, identification, or receiver AGR circuits (3.4.3.12).

3.5 Antenna design, functional and performance requirements.- The type of antenna described hereunder is an omni-directional type (3.5.2).

3.5.1 Not used.-

3.5.2 Omni-directional antenna.- Each omni-directional antenna shall be in accordance with the requirements of paragraphs 3.5.3 through 3.5.13. All requirements shall be met with a single antenna design.

3.5.3 Frequency range.- All requirements specified hereinafter shall apply through the frequency band of 960 to 1215 MHz without tuning or adjustment. The power gain and pattern characteristics are free space parameters and shall be met with the antenna radome in place.

3.5.4 Polarization.- The predominant energy radiated by the antenna shall be vertically polarized.

3.5.5 Characteristics impedance and VSWR.- The antenna unit shall have a design center characteristic impedance of 50 ohms. The VSWR, as measured at the end of a low loss cable not exceeding five feet in length shall not be greater than 2:1 throughout the specified range of frequencies.

3.5.6 Antenna gain.- The antenna shall have a gain at the maximum power point of the vertical pattern of not less than 8.0 dB at all azimuths.

3.5.7 Vertical field pattern.- The radiation pattern of the antenna in the vertical plane shall have a lobe of energy not less than 5 degrees wide at the half-power points. The vertical angle of maximum radiated energy shall be between 2.0 degrees and 5.0 degrees above the horizon. The power gain on the horizon shall not be less than 6 dB. The signal intensity of the radiated energy at an elevation angle of 1.0 degree above the horizon shall be at least 0.20 volts per meter above the signal intensity of the radiated energy at an elevation angle of 1.0 degree below the horizon where the intensity is normalized to the value at the horizon. The power gain at angles between 6 and 50 degrees below the horizon shall be lower than the power gain at the peak of the major lobe above the horizon by at least 8 dB. The power gain at angles between 6 and 15 degrees above the horizon shall be greater than a level which is 20 dB below the power gain at the peak of the major lobe above

the horizon. The power gain at angles between 15 and 45 degrees above the horizon shall be greater than a level which is 30 dB below the power gain at the peak of the major lobe above the horizon.

3.5.8 Horizontal field pattern.- The antenna shall have an omni-directional radiation pattern. The ratio of the power density at the angle of maximum radiation to the power density at the angle of minimum radiation, both on the horizon, shall not exceed 2 dB.

3.5.9 Radome and weatherproofing.- The radome shall be smooth and shall minimize wind loading and the accumulation of water, snow and ice. The entire antenna assembly including cable connectors shall be effectively sealed (weatherproofed) to prevent the entrance of foreign matter in such a manner as to permit removal and replacement of the radome without the necessity of sealing compounds.

3.5.10 Antenna mounting.- The configuration of the antenna base shall be such that the antenna may be mounted directly, or indirectly through use of an adaptor furnished with each antenna, to a standard 4-inch steel pipe (nominal outside diameter of 4.5 inches). The mounting fixture shall engage not less than 6" of the pipe and shall be provided with clamping screws and locknuts for securing the fixture to the pipe. The design shall provide unobstructed access to all connectors.

3.5.11 Vibration and wind loading.- The antenna and its mounting fixture shall be capable of withstanding without damage: (a) sustained vibration at the resonant frequencies of the assembly for a continuous period of not less than 125 million cycles, and (b) wind loading in gusts at velocities of not less than 100 miles per hour. The contractor may demonstrate compliance with requirement (a) above by means of design calculations and limited vibration testing to determine the resonant frequencies of the assembly. When design calculations are used, the calculations shall be based on the properties and characteristics of the materials as used. Compliance with the requirements of (b) above may be demonstrated by static loading in lieu of wind testing.

3.5.12 Monitor probes.- Two coupling probes, for monitoring the signal radiated by the antenna, shall be provided within the antenna radome and separately terminated in 50 ohms resistance load at capped weather-proofed coaxial connector at the base of the antenna. The rf coupling factor for each probe shall be as required to achieve monitoring in accordance with paragraph 3.6.4.6 and shall not vary from the design center value by more than 0.5 dB throughout the range of ambient conditions specified for environment III. Additionally, the difference in output level between probes shall not exceed 2 dB.

3.5.13 Antenna cables.- The contractor is not required to furnish coaxial cables for the antenna and its monitor probes, but shall furnish coaxial connectors in accordance with paragraph 1-3.16.3.1 of FAA-G-2100/1 for

use by the Government at the time of equipment installation. The connectors furnished shall accommodate 7/8" Foamflex cable for the main antenna transmission line and type RG-214/U cable for the main monitor probe transmission lines. The mating connectors on the antenna shall be of the type required for the cable connectors furnished. Connectors for obstruction light power circuits shall also be provided.

3.5.14.- Obstruction lights.- A dual lamp obstruction light fixture, GE Type A21, or equal, with red cover globes shall be provided on the DME antenna radome. Lamps shall be 100W, 120VAC, 1250 lumens, incandescent.

3.6 Monitor design, functional and performance requirements.- The monitor equipment shall consist of the following items which provide the basic functions indicated below in accordance with the requirements of paragraphs hereunder:

- (a) An interrogation signal generator for monitoring and testing of the transponder response to interrogation signals; and
- (b) A transponder monitor providing for monitoring and testing of the transponder output signals.

The monitor shall incorporate facilities for adjustment to the desired fault threshold points, the sensing and visual indication of the faults of paragraphs 3.6.4.2 through 3.6.4.7 inclusive and for the determination and maintenance of the level of DME performance characteristics required under paragraph 3.8 of this specification. Performance of the monitor shall be fail-safe and independent. A fault condition shall exist under conditions wherein one or more monitored characteristics are sensed as being outside acceptable limits as established by the corresponding threshold adjustments.

3.6.1 Operating channels.- Monitors shall provide the specified performance on each of the channels listed in Table I when the proper frequency determining crystals are installed. Except for installation of the appropriate crystals, no component changes shall be required for operation on any other Channel assignments, including both "X" and "Y" channels. Each equipment shall be furnished with a complete set of operating crystals (installed) and a duplicate set of spare crystals for operation on the assigned channel.

3.6.1.1 Frequency accuracy and stability.- For each output frequency required from the signal generator, the output radio frequency shall be within 0.002 percent of the exact frequency specified.

3.6.2 Monitor rf input and output signal coupling.- The monitoring of radiated power (3.6.4.6) shall be accomplished through the sampling of rf signals from the monitor probes of paragraph 3.5.12. The power monitoring detector shall be within the monitor equipment. The remaining monitoring functions shall be accomplished through the injection and sampling of rf signals through transmission line directional couplers.

3.6.3 Interrogation signal generator.- The interrogation signal generator shall provide interrogation and timing reference signals for the relevant functions of the transponder monitor and, when used with the test equipment furnished under paragraph 3.8, shall provide the capability for determining and maintaining the performance of the transponder in response to interrogation signals.

3.6.3.1 Operational modes.- The signal generator shall produce CW and pulsed rf output signals in accordance with the indexing of a front panel function selector switch labeled OPERATING MODE as follows:

- (a) Position 1 labeled NORM shall provide for normal monitoring operation with internally timed and generated interrogation pulse pairs occurring at the repetition rate within the limits of 25 to 40 pulse pairs per second. The spacing of the constituent pulses of each pair shall conform to the requirements of paragraph 3.6.3.5. For this Position 1 only, alternate pairs of interrogation pulses shall be at a level of $-30(+3)$ dBm for Reply Delay monitoring (resulting in a nominal receiver input of -60 dBm). The remaining pulses shall be at the level set by the Interrogation Level control (3.6.3.12).
- (b) Position 2 labeled EXT TRIG shall provide for internally generated interrogation pulse pairs occurring at all rates between the limits of 20 to 4800 pulse pairs per second in response to each trigger pulse from the video test generator of paragraph 3.8.2.1. The spacing of the constituent pulses of each pair shall be as specified in paragraph 3.6.3.5.
- (c) Position 3 labeled EXT PAIRED TRIG shall provide for internally generated interrogation pulse pairs having the repetition rate and spacing of the paired test pulses of the video test generator. (These pulses shall be connected by semi-permanent cable to a BNC jack on the rear panel of the signal generator. In this Position 3, the signal generator shall derive trigger pulses from each test pulse.)
- (d) Position 4 labeled MON TEST shall provide the same functions as Position 2. In addition, the video input of the Transponder Monitor shall be automatically disconnected from the normal directional coupler derived output and connected instead to the paired test pulses of the video test generator (see subparagraph c above) for testing of the pulse spacing, reply efficiency, and reply delay circuits of the monitor. Position 4 shall also provide for zero setting of the power level calibration indicator. (In the pulsed mode of operation the average power output may be assumed to be zero for this purpose.)

- (e) Position 5 labeled CW shall provide for unmodulated CW output and adjustment of the rf output to a reference calibration level.

Alternate arrangements, such as the use of combinations of individual switches, may be employed to accomplish the above function provided that all requirements of paragraphs 3.6.3.11, 3.8 and 3.8.1 are met.

3.6.3.2 Trigger out pulse.- An output trigger pulse coincident with the initiation of interrogation pulse pairs from the Interrogation Signal Generator shall be provided on the front panel of the Interrogation Signal Generator at a BNC jack labeled TRIGGER OUT. The trigger pulse characteristics shall be appropriate for reliable operation of the oscilloscope of paragraph 3.8.2.4.

3.6.3.3 Timing reference pulse.- For reply delay time monitoring, the signal generator shall provide a timing reference output pulse coincident with the 50 percent maximum voltage amplitude point on the leading edge of the first constituent rf pulse of each interrogation pulse pair. This requirement shall be met at all interrogation signal pulse rates from 20 to 4800 pulse pairs per second. In addition, the timing reference pulse shall be provided on the front panel of the Monitor at a BNC jack labeled INTERROGATION COUNT.

3.6.3.4 RF output pulse signal.- The rf envelope of each pulse, as detected by a linear detector, shall have a shape falling within the following limits.

3.6.3.4.1 Pulse rise time.- The rise time shall be 2.5 (+0.5, -1.0) μ sec.

3.6.3.4.2 Pulse top.- The instantaneous amplitude of the pulse shall not at any instant between the point on the leading edge which is 95 percent of the maximum voltage amplitude and the point on the trailing edge which is 95 percent of the maximum voltage amplitude, fall below a value which is 95 percent of the maximum voltage amplitude.

3.6.3.4.3 Pulse duration.- The pulse duration shall be 3.5 (± 0.5) μ s.

3.6.3.4.4 Pulse decay time.- The decay time shall be 2.5 (+0.5 -1.0) μ sec.

3.6.3.5 Pulse coding.- When the function selector switch is indexed to position 1, 2 or 4, pulses shall be coded in pairs with a spacing, as measured between the 50 percent maximum voltage amplitude point on the leading edge of the first rf pulse to the corresponding point on the leading edge of the second rf pulse, of (a) 12 (± 0.2) μ s for channel numbers ending in the suffix "X" or, (b) 36 (± 0.2) μ s for channel numbers ending in the suffix "Y".

3.6.3.6 Pulse power variation.- The difference in rf power level at the peak of the constituent pulses of each pulse pair shall not exceed 0.5 dB.

3.6.3.7 Detected rf output signal.- To provide for determination of pulse characteristics and for timing measurements referenced to the 50 percent voltage amplitude point on the leading edge of each rf pulse, a video waveform corresponding in shape and time to the envelope of each rf pulse shall be provided for display as required under 3.8.1. The rf envelope reproduction and time coincidence characteristics of the output signal as displayed on the oscilloscopes of paragraph 3.8.2.4 shall be as necessary to meet the requirements of item (1) of paragraph 3.8.1 and, when used in conjunction with the power diode output signal of paragraph 3.8.2.2.3, to meet the requirements of item (12) of paragraph 3.8. The detected rf output signal shall be available at a front panel BNC jack labeled SIG GEN ENVELOPE.

3.6.3.8 RF pulse spectrum.- At least 90 percent of the output signal rf energy shall be contained within a 0.5 MHz band centered on the interrogation frequency in use. The remaining energy shall be essentially equally distributed on both sides of the 0.5 MHz band centered on the interrogation frequency and shall diminish in level at frequencies further removed from the channel frequency.

3.6.3.9 Spurious output.- At all frequencies from 27 to 1660 MHz, but excluding the band of frequencies from 1039 to 1085 MHz, the spurious output as measured at the rf output connector of the signal generator shall not exceed -40 dBm/kHz of receiver bandwidth. In addition, the power at the rf output connector during the intervals between occurrence of the desired interrogation pulse pairs shall not exceed a level of -80 dBm for all settings of the output attenuator.

3.6.3.10 Test rf output frequencies.- A front panel rotary selector switch shall provide for the selection of rf output at the channel interrogation frequency, at plus and minus 200 kHz and at plus and minus 900 kHz with respect to the nominal interrogation frequency in use. All signal generator performance requirements shall be met without retuning or re-adjustment of any controls when each of the output frequencies referenced herein are selected. The rf output at ± 200 kHz and ± 900 kHz shall be within 0.5 dB of the rf output at the nominal interrogation frequency.

3.6.3.11 RF output level calibration.- A thermistor bridge or diode detector and meter shall be incorporated for setting the rf power to a reference calibration level. The rf power shall be automatically maintained at the calibration level under all conditions of pulsed operation. Any deviation from the reference calibration level shall be indicated by a front panel meter. A front panel control(s) shall be provided for setting the rf power output to the calibration level and for zero setting of the thermistor bridge, if employed - (see last sentence of 3.6.3.1(d)).

3.6.3.12 RF output level and accuracy.- The rf output level shall be continuously variable between the limits of zero dBm and -80 dBm as measured in a 50 ohm resistance load at the rf output connector. The output attenuator shall have an essentially linear scale calibrated in increments of 1 dB over the specified range. After calibration as required under paragraph 3.6.3.11 hereof, the rf output level over the range of interrogation frequencies shall be within 1.0 dB of the level indicated by the attenuator dial when measured in a 50 ohm resistance load at the rf output connector.

3.6.4 Transponder monitor.- The subparagraphs hereto identify the performance characteristics to be monitored, the applicable range of adjustments and the conditions under which a fault condition shall exist. The requirements shall be met when the initial transponder power output has any value between the limits of +3 to -3 dB relative to the power output required under paragraph 3.4.7.4 and when the rf cables (3.5.10) between the DME antenna and the monitor and transponder cabinets are of all lengths between the limits of 10 to 60 feet each. Under conditions in which the power density of undesired rf pulse signals in space at the location of the DME antenna is of all values up to 50 dBm/m², the monitor shall not respond to, nor shall its performance be affected by, undesired signals which are non-synchronous to the DME output signals being monitored.

3.6.4.1 Monitor alarm action.- The monitor shall provide two separate output alarm actions for purposes of automatic control and remote monitoring of the DME facility, one designated "primary parameter alarm" and the other designated "secondary parameter alarm." A primary parameter alarm output shall be produced whenever an out of tolerance condition has existed in the reply delay parameter (3.6.4.3) for the prescribed period of time (3.6.4.1.1). A secondary parameter alarm shall be produced when an out of tolerance condition has existed in any one or more of the remaining monitored parameters (3.6.4.2 through 3.6.4.7 less 3.6.4.3) for the prescribed period of time (3.6.4.1.1). The monitor shall be capable of operation with any combination of the monitored parameters (3.6.4.2 through 3.6.4.7) providing primary parameter alarm action. Choice of the mode of operation shall be made by means of jumper connection(s) or switches easily accessible on the monitor chassis. An additional switch or jumper shall be provided to select a mode of operation whereby a secondary parameter alarm will result in removal of the identification equalizer pulse pairs (3.4.4) from the transponder. The output circuits shall be designed so as to produce a closed circuit (continuity) to circuits of the control equipment (3.7 et seq.) in the non-alarm condition and an open circuit in the alarm condition.

3.6.4.1.1 Alarm delay time.- The alarm switching devices shall operate following the sensing of one or more faults after such faults have existed for a preset period of time. For each of parameters 3.6.4.2 through 3.6.4.6 the time period shall be determined by the setting of individual controls. The controls shall provide for adjustment of the time delays

to all intervals between the limits of 4 to 10 seconds. Any setting shall be stable to within 1 second over the service conditions. (See paragraph 3.6.4.7 for identification alarm delay.)

3.6.4.1.2 Monitor response time.- The following requirement shall be met under conditions in which all faults have been sensed for a continuous period of 10 seconds, or longer. Within 3 seconds after the application of transponder output signals which have characteristics that are all within a range prescribed for non-fault conditions, all fault sensing and alarm indication shall end and the contacts of the alarm switching devices (3.6.4.1.3) which control shutdown or transfer shall be closed. This requirement shall be met whenever main power has been applied to the monitor equipment for intervals equal to and greater than 2 minutes (modifies FAA-G-2100/1 para. 1-4.12 step 6).

3.6.4.2 Reply efficiency monitor.- The reply efficiency monitor shall respond to the percentage of replies transmitted in response to monitor or test signal generator interrogations at the level determined by the signal generator output attenuator (3.6.3.12). (This excludes replies to the alternate pair of pulses provided under paragraph 3.6.3.1(a) for reply delay monitoring). Replies to interrogation shall be those replies falling within an acceptance gate adjustable to correspond to any nominal beacon reply delay setting in the range of 3.4.5.3. The width of the gate shall be not less than 3.0 μ sec nor greater than 5.0 μ sec. The position of the center of the gate shall not vary more than ± 0.25 μ sec over the service conditions. The fault threshold point for reply efficiency shall be adjustable between the limits of 45 to 65%. The adjustment shall either be continuous or in increments of not greater than 5%. The alarm condition shall exist whenever the reply efficiency is reduced to the threshold point ($\pm 5\%$) and lower values. The above requirements shall be met for any and all monitor signal generator interrogation rates between 20 and 400 ppps. A blue jeweled front panel indicator light designated REPLY EFFICIENCY shall be provided. The indicator shall be energized only when a fault condition does not exist.

A BNC jack labeled REPLY COUNT shall be provided on the monitor front panel for the purpose of counting the synchronous replies to monitor signal generator interrogations routed through the interrogation level control attenuator (3.6.3.12).

3.6.4.3 Reply delay monitor.- The reply delay monitor shall respond to the position of replies transmitted in response to signal generator interrogations. The fault threshold point shall be reached whenever the reply delay of the transponder as determined by the position of the first constituent reply pulse deviates from its nominal setting by ± 0.4 (± 0.1) μ s and more. When the OPERATING MODE selector switch is in the NORMAL position (3.6.3.1(a)), the reply delay monitor shall respond only to the replies generated in response to the alternate pulse pair interrogation. (-30 dBm level) of the signal generator.

The above requirements shall be met for any and all interrogation rates between 20 and 400 ppps. A blue jeweled front panel indicator light, designated REPLY DELAY shall be provided. The indicator light shall be energized only when a fault condition does not exist.

3.6.4.4 Output pulse spacing monitor.- The output pulse spacing monitor shall respond to the spacing of the transponder output pulse pairs. The fault threshold point shall be reached when the spacing deviates from the design center value for the channel in use by ± 0.4 (± 0.1) us and more. This requirement shall be met at all input pulse rates (including test pulse inputs, see 3.6.3.1.d) within the range of 20 to 4200 ppps. A blue jeweled front panel indicator light, designated PULSE SPACING shall be provided. The indicator shall be energized only when a fault condition does not exist.

3.6.4.5 Transponder pulse rate monitoring.- A fault condition shall exist when the transponder output pulse rate decreases to 850 (± 100) pulse pairs per second and lower values. A blue jeweled front panel indicator lamp designated PULSE RATE shall be provided. The indicator shall be energized only when a fault condition does not exist.

3.6.4.6 Transponder power output monitoring.- Power monitoring circuitry shall respond to the amplitude level of pulses radiated by the DME antenna as received by the monitor pickup probes of 3.5.12. A fault threshold shall be reached whenever the peak power level of radiated energy as sampled by the pickup probes decreases to any preselected level within the range of -0.5 to -6.0 dB relative to that produced when the transponder power output has any initial value specified under paragraph 3.6.4. The fault threshold point shall remain within 0.5 dB of each initially selected fault threshold level within the referenced selection range. After the sensing of a fault, an increase of 0.5 dB in the transponder output as referenced to the fault threshold point, and all greater increases, shall end the sensing of a fault. A front panel indicator lamp having a blue jewel and designated POWER OUTPUT shall be provided. The indicator shall be energized only when a fault condition does not exist.

3.6.4.7 Identification signal monitoring.- A fault condition shall exist whenever the keyed identification signal is not repeated within 75 (± 10) seconds. (The condition of continuous identification need not be monitored as this will result in reply efficiency and reply delay alarms. The alarm delay time of 3.6.4.1.1 shall preclude alarms during normal identification keying.) A blue jeweled front panel indicator lamp designated IDENTITY shall be provided. The indicator shall be energized only when a fault condition does not exist. (See 3.7.1.4 for automatic resetting of the time delay feature.) The circuits monitoring the identification signal shall operate through sensing the fundamental component of the identification pulse train (1350 Hz nominal) and shall not be affected by the presence or absence of equalizing pulses (see 3.4.3).

3.7 Control equipment design, functional and performance requirements.- Paragraph 3.7.1 and the subparagraphs thereto contain requirements for a control unit to be furnished with each set of DME. The design of all

equipment shall be such as to provide fail-safe operation and remote alarm indication; i.e., failures of an open circuit nature such as failure of a relay coil, failure of relay "A" contacts to close, failure of a power supply, or loss of signal voltage shall result in removal of the DME from operation and remote alarm indication rather than prevention of station shutdown or a possibly erroneous remote indication of normal station operation. In controlling the application of high voltage to a transponder, the control circuitry involved shall control switching devices within the transponder (see paragraph 3.4.6). The application of high voltage shall, however, be contingent upon the circuit condition of any protective devices, interlocks and other control devices which are a part of each transponder.

3.7.1 Control unit.- In accordance with the requirements hereof, the control unit shall:

- (a) provide for local and remote control of the DME;
- (b) provide for local and remote indication of monitor alarm condition;
- (c) provide for automatic shutdown of the transponder in response to alarms sensed by the monitor equipment.

3.7.1.1 Remote control dial functions.- The control unit shall include devices, circuitry and termination therefor which are necessary to provide remote control operation as required by this specification through the remote control unit and dial control system of an associated VHF facility. The dial control machine switch or other switching circuitry in the associated VHF facility will, upon dialing of each of the codes listed hereunder or other remotely controlled switching action, provide a grounding pulse for the DME control switching circuitry or relay(s) associated with the corresponding dial code. The grounding pulse will provide completion to ground of relay coil circuits in the associated VHF facility, having -48 volts DC on the common terminals as required to accomplish the listed functions and conditions. The duration of the grounding pulse provided through the VHF facility will depend solely on the length of time that the dial key is held depressed; however, the required performance shall be achieved when the duration of the grounding pulse is as short as 0.25 second. An example of the VHF control and interconnecting circuitry is shown in Figure 1. Since dial codes 04 and 06 are also utilized to perform equivalent functions in the associated VHF facility, the DME control equipment shall have diodes in series with the relay coils associated with the referenced dial functions which provide isolation between the 48 volt power supplies in each of the equipments.

<u>Dial code</u>	<u>Function</u>	<u>Condition</u>
04	Transponder enable.	Restores operation after dial code 06.
06	Transponder shutdown	Transponder high voltage off until dial code 04 is activated.

51	Transponder on.	Transponder high voltage on.
52	Transponder off.	Transponder high voltage off.
73	Status reset.	Restores operation after automatic shutdown.
75	DME monitor bypass	(See paragraph 3.7.1.3.1.3)
77	DME monitor normal.	(See paragraph 3.7.1.3.1.3)

3.7.1.1.1 Dial code 04.- When the Local-Remote switch of paragraph 3.7.1.6 is in the Remote position and high voltage has previously been removed from the transponder either through the dialing of function 06 or through automatic shutdown (paragraph 3.7.1.2), the dialing of function 04 shall result in reapplication of high voltage to the transponder.

The dialing of function 04 shall also accomplish the reset function of 3.7.1.4.

3.7.1.1.2 Dial code 06.- When the Local-Remote switch (3.7.1.6) is in the Remote position, the dialing of function 06 shall result in the removal of high voltage from the transponder. When 06 has been dialed, high voltage shall not be applied to a transponder as a result of dialing 51 or 73 until 04 is dialed.

3.7.1.1.3 Dial codes 51 and 52.- The dialing of code 51 shall result in the application of high voltage to the transponder (except see 3.7.1.1.2 above) and accomplishment of the reset function of 3.7.1.4. The dialing of code 52 shall remove high voltage from the transponder.

3.7.1.1.4 Dial code 73.- When the Local-Remote switch (3.7.1.6) is in the Remote position and high voltage has been removed from the transponder through automatic shutdown (3.7.1.2), the dialing of function 73 shall result in the reapplication of high voltage to the transponder and accomplishment of the reset function of 3.7.1.4. Dialing of this function shall not, however, be effective in reapplication of high voltage after shutdown in response to dial code 06 (see 3.7.1.1.2).

3.7.1.1.5 Dial codes 75 and 77.- See paragraph 3.7.1.3 and the subparagraphs thereto for conditions applicable to dial functions 75 and 77.

3.7.1.1.6 Retention of status.- The switching devices or relays associated with dial functions 04 and 06, 51 and 52, and 75 and 77 shall be of the latching type or equivalent devices in which retention of the status corresponding to the selected dial function is not dependent upon the presence of control voltages.

3.7.1.2 Automatic shutdown.- When the Local-Remote switch is in the Remote position, the control unit shall cause the removal of high voltage from the operating transponder in response to primary parameter alarm action (3.6.4.1.3).

3.7.1.3 Alarm signal control and indication.- The control unit shall provide both remote alarm signal control and local alarm indication hereto whenever an alarm condition exists. Local and remote alarm indications shall be provided for the case of a primary parameter alarm, a secondary parameter alarm, or both simultaneously. (See also 3.4.4 and 3.6.4.1).

3.7.1.3.1 Remote alarm signals and control.- Circuits equivalent to those of Figure 2 shall be provided to permit optional use by the Government of either of two signaling arrangements in accordance with the requirements of the following subparagraphs. Control circuit wiring and shielded signal circuit wiring shall be terminated at a cabinet terminal board for connection to external circuits.

3.7.1.3.1.1 48 volt DC alarm signal.- A -48 volt DC signal with 0.2 Amperes capacity shall be provided for operation of a remote alarm indicating device provided by the Government. Under conditions wherein the monitor alarm bypass of paragraph 3.7.1.3.1.3 is not activated, the signal shall be present at the output terminals only when the monitor equipment does not sense an alarm condition.

3.7.1.3.1.2 External tone alarm signal.- Send and receive circuitry shall be provided for audio tone signals one at 2820 Hz and the other at 2940 Hz, either individually or together, for operation of an associated remote alarm indicating device. All circuitry for this signal shall be ungrounded and isolated from that of paragraph 3.7.1.3.1.1. Under conditions wherein the monitor alarm bypass of paragraph 3.7.1.3.1.3 is not activated, the external tone signal shall be present at the output terminals according to the following subparagraphs:

3.7.1.3.1.2.1 Tone generators.- The equipment shall generate audio tones of 2820 Hz and 2940 Hz by countdown of signals from crystal oscillator circuitry to provide the required stability over the full range of operating conditions. The 2820 Hz tone shall be provided continuously and the 2940 Hz tone shall be provided at a one-second-on/one-second-off rate. Under normal operation of the monitor, the 2820 Hz continuous tone shall be applied to the remote control line. Upon sensing of a secondary parameter alarm, this tone shall be replaced by the pulsated 2940 Hz tone. Upon sensing of a primary parameter alarm, both tones shall be removed from the line (see Figure 3 attached). The tone generator shall meet the following requirements:

Frequency
2820 Hz
2940 Hz

+1.0 Hz
-1.0 Hz

Output Circuit

Ungrounded transformer
secondary having a nominal
output impedance of 600 ohms.

Output Level	Adjustable from 0dBm to +15 dBm for the 2820 Hz tone and from +3 dBm to +18 dBm (average power during the on period) for the 2940 Hz tone.
Output Level stability	+ 1.0 dB from setting over operating range and ambient temperature range.
Harmonic distortion	No greater than 5% at full output.
Noise	-40 dBm maximum (Output Level control at mid-level).
Output Jack	A telephone bridging type jack, MIL Type JJ-033, shall be provided and connected across the output terminals of each oscillator. The connection shall be made to the two ungrounded contacts of the jack.
Physical construction	Incorporated in Monitor, Control or Status Indicator equipments. No controls on the front panel.

3.7.1.3.1.3 DME alarm bypass.- When dial function 75 is activated, the remote alarm signals of paragraphs 3.7.1.3.1.1 and 3.7.1.3.1.2 shall each be present at the respective output terminals at all times regardless of the operating condition and operational status of transponder and monitor equipment. The dialing of function 77 shall open circuit the alarm bypass and restore operation in accordance with the requirements of paragraphs 3.7.1.3.1.1 and 3.7.1.3.1.3. A front panel switch shall be provided for activation and deactivation of the DME alarm bypass. An amber jeweled indicator lamp shall be energized whenever the alarm is bypassed. The switch described shall be effective in energizing the "Remote Alarm Relay" of Figure 2. The switch shall be effective in the local position only.

3.7.1.3.2 Local alarm signals and control.- Visual and aural local alarm indicators shall be provided in accordance with the requirements of the subparagraphs hereto.

3.7.1.3.2.1 Visual alarm indicator.- A front panel indicator lamp having a blue jewel shall be energized whenever the remote alarm relay is energized.

3.7.1.3.2.2 Aural alarm indicator.- A buzzer shall provide an aural alarm indication in response to an aural alarm condition. The buzzer shall operate only when the Local-Remote switch of paragraph 3.7.1.6 is in the Local position. A manually operated switch shall be provided to permit silencing of the buzzer when desired. The switch shall be readily accessible behind the unit front panel upon partial withdrawal of the unit from the cabinet. Restoration of the drawer to the closed position shall reset the switch to the position required for operation of the buzzer. The buzzer shall not be activated by the dialing of DME alarm bypass.

3.7.1.4 Transponder and monitor reset functions.- Each dialing of functions 04, 51, or 73 shall automatically reset all overload relays or protective devices (3.4.6.2) of the transponder and shall also recycle the 75 (+10) second time delay feature of the identification signal monitor. In order to prevent automatic shutdown during the period of initial equipment stabilization (3.4.8 and 3.6.4.1.2) such action shall be inhibited for a period of 3 to 10 seconds. The time delay interval shall be continuously adjustable between these limits. Each dialing of functions 04, 51, or 73 shall recycle the time delay interval.

3.7.1.5 Status reset switch.- A momentary contact push button switch shall be provided on the front panel and, when depressed, shall result in the identical action as the dialing of function 73 when the Local-Remote switch is in the Remote position.

3.7.1.6 Selection of local or remote control.- A two position switch shall be provided on the front panel for selection of local or remote control operation. When the switch is in the Local position, neither dial functions 04, 06, 51, 52 and 73, or the status reset switch of paragraph 3.7.1.5 shall be effective in the application or removal of high voltage to transponder equipment, nor shall equipment shutdown result from monitor alarm conditions. The application of high voltage to a transponder under conditions of alarm control shall be governed by the position of the high voltage switch on the transponder. Operation of the Local-Remote control switch to the Remote position shall, in addition to restoring remote control, disable local control circuits and, when the 04/06 function relay is in the 04 position, cause the transponder to function. Indexing of the Local-Remote control selector switch to either position shall not affect the DME alarm bypass status or the ability to dial functions 75 and 77.

3.7.1.7 Normal operating mode indicator lamp.- A front panel indicator lamp having a blue jewel shall be provided to indicate that switches as identified below are in the correct position for normal unattended operation of the ground station equipment. The light shall be energized only when all of the following conditions are satisfied.

- (a) the Local-Remote switch is in the Remote position;
- (b) the function selector switch (3.6.3.1) in the monitor is in position 1; and
- (c) the identity keying control switch (3.4.4.2) in the transponder is in position 1.

3.8 Test equipment design, functional and performance requirements.- To the extent necessary to achieve and maintain the performance characteristics specified for the transponder and monitor equipment, it shall be possible with the test equipment furnished by the contractor and an oscilloscope identified in paragraph 3.8.2.4 to:

- (a) Adjust, measure and test all pulse amplitude, waveform and timing characteristics of the transponder and monitor equipment;
- (b) Adjust, measure and test all the performance and response characteristics of the transponder to interrogation signals;
- (c) Test for and measure the performance characteristics identified in paragraph 3.8.1 to the accuracy specified for each characteristic using only the monitor equipment and the test equipment; and
- (d) Perform all trouble-shooting and corrective maintenance operations using only the Government furnished station test equipment listed hereunder in addition to the test equipment of paragraph 3.8.2 et seq.
 - 1. VTVM, HP model 410 B, or equal
 - 2. 50 ohm, 50 watt rf load, Bird model 8130 or equal
 - 3. Semiconductor device testers
 - 4. RF marker and sweep generator, Kay Electric Company model 121cFA Multisweep, 1 to 1300 MHz, or equal.

The requirements of (a), (b) and (c) shall be met in a manner which does not necessitate interrupting operational use of the transponder. Each item of test equipment furnished by the contractor shall include all those accessory items, such as probes, cables, adaptors, termination devices and detectors, the use of which is necessary to the proper accomplishment of (a) through (d) above.

3.8.1 DME performance test and measurement capability.- The listing hereunder identifies minimum performance test and measurement capability within the scope of paragraph 3.8 (c) which shall be provided. The transponder, monitor and test equipment shall each provide features and characteristics as necessary to achieve the required adjustment, test and measurement capability. The facilities provided shall be such as to facilitate and permit all test and measurement operations to be accomplished in the most simple and expeditious manner from the front of the equipment through means such as cable connectors, controls and switches as needed on the relevant sub-assemblies of the equipment. For the measurement of reply delay time, signal generator interrogation and transponder reply pulse pairs shall each be displayed on a common oscilloscope

time base. The direction of vertical deflection on the oscilloscope display shall be the same for each of the signals and means shall be incorporated through which the amplitude of the two signals, as displayed, may be adjusted to equal values. All timing measurements which are directly or indirectly timed by the monitor signal generator or by pulses derived from the video test generator of paragraph 3.8.2.1 shall be made with the simultaneous display of time markers and the signals between which timing measurements are to be made. When the video test generator and oscilloscope are used for timing measurements, the markers shall produce a vertical deflection on the oscilloscope in the same direction as the video signals being timed and the deflection produced by the marker signals shall be adjustable from zero to a value equal to that of the other video signals displayed.

<u>Performance Characteristics</u>	<u>Accuracy</u>
1. Signal generator pulse duration, rise and decay times:	± 0.1 us
2. Signal generator interrogation coding:	± 0.1 us
3. Signal generator interrogation rate:	± 5.0 percent
4. Transponder receiver noise decode rate:	± 5.0 percent
5. Transponder rf output pulse duration, rise and decay times:	± 0.1 us
6. Transponder rf output pulse coding	± 0.1 us
7. Transponder rf power output:	± 0.5 dB
8. Transponder receiver decode aperture:	± 0.1 us
9. Transponder receiver echo suppression:	± 1.0 dB
10. Transponder receiver sensitivity:	
(a) -900 kHz relative to channel frequency:	± 1.5 dB
(b) -200 kHz relative to channel frequency:	± 1.5 dB
(c) On-channel frequency:	± 1.5 dB
(d) +200 kHz relative to channel frequency:	± 1.5 dB
(e) +900 kHz relative to channel frequency:	± 1.5 dB
11. Transponder dead time:	± 2.0 us
12. Transponder reply delay time:	± 0.1 us
13. Transponder replies to signal generator interrogations:	± 5.0 percent

- | | |
|---|-------------------|
| 14. Transponder identity signal pulse group rate or period: | ± 0.5 percent |
| 15. Transponder identity signal pulse group coding: | ± 2.0 us |
| 16. Transponder output pulse rate: | ± 5.0 percent |
| 17. Monitor pulse rate fault threshold: | ± 5.0 percent |
| 18. Monitor reply efficiency fault threshold: | ± 5.0 percent |
| 19. Monitor reply delay time fault threshold: | ± 0.1 us |
| 20. Monitor pulse spacing fault threshold: | ± 0.1 us |

3.8.2 Complement of test equipment.- The test equipment furnished shall include items which, in addition to meeting the requirements of paragraphs 3.8.2.1 to 3.8.2.3, provide all other features, functional capability and performance characteristics necessary to meet the requirements within the scope of paragraph 3.8 et seq. The items covered by paragraphs 3.8.2.1 to 3.8.2.4 shall be mounted in the equipment cabinetry in such a location and manner as to facilitate their use. (While the oscilloscope 3.8.2.4 is not required to be furnished under this specification, the contractor shall nevertheless provide space in the equipment cabinet for mounting.)

3.8.2.1 Video test generator.- The video test generator shall provide the following features:

- (a) Crystal controlled markers, connected by internal cabinet wiring to the oscilloscope of 3.8.2.4, for time base calibration purposes. The selection of marker spacings shall include 1.0, 6.0, 10.0, and 100 us as a minimum.
- (b) A master trigger pulse obtained by counting-down of crystal markers and synchronous therewith. The master trigger output pulse, shall be connected by internal cabinet wiring to the oscilloscope of 3.8.2.4. The master trigger rate shall be adjustable throughout the range of 20 to 4800 pulses per second.
- (c) A monitor trigger pulse. The monitor trigger pulse shall be connected by internal cabinet wiring to the interrogation signal generator and, when the function selector switch (3.6.3.1) is in Positions 1, 2, or 4, shall provide for the triggering of signal generator interrogations. The monitor trigger pulse shall be adjustable in position throughout the range of 10 to 30 us delayed with respect to the master trigger.
- (d) Trigger pulse pairs. The trigger pulse pairs shall be connected by internal cabinet wiring to the interrogation signal generator,

and, when the function selector switch (3.6.3.1) is in Position 3, shall provide for triggering of signal generator interrogations at pulse spacings determined by the video test generator. The position of the first trigger shall be continuously adjustable in position throughout the range of 10 to 100 u sec delayed with respect to the master trigger and the position of the second trigger shall be continuously adjustable in position throughout the range of 8 to 40 u sec delayed with respect to the first trigger. (As an alternate to the provision of trigger pulse pairs, the contractor, may, at his option, derive the triggers from the video pulse pairs of sub-paragraph (e) below provided the required stability can be achieved through this method.)

- (e) Video pulse pairs. The video pulse pairs shall be connected by internal cabinet wiring to the interrogation signal generator, and, when the function selector switch (3.6.3.1) is in position 4 shall provide for the use of the video pulse pairs as simulated reply pulses for testing the operation of the monitor reply delay and pulse spacing circuits. The position and spacing of the video pulse pairs shall be as specified for the trigger pulse pairs of sub-paragraph (d) above. The pulses shall be rounded or trapezoidal in shape with a rise time of 2.5 ± 0.5 u sec.

The maximum jitter between markers, triggers, and pulses, each with respect to the other shall not exceed 0.05 us.

3.8.2.2 Power diode assembly.- A power diode assembly and associated circuitry shall be provided on the Test Unit of paragraph 3.8 for measurement, using the oscilloscope of paragraph 3.8.2.4, of transmitter rf power levels and pulse characteristics.

3.8.2.2.1 Voltage standing wave ratio.- When the power diode assembly is interconnected to each of the rf signal couplers with which it is used, the VSWR in the interconnecting rf cables shall not exceed 1.25.

3.8.2.2.2 Accuracy of power measurements.- The power diode assembly with associated rf couplers and interconnecting rf transmission lines shall provide measurement of incident pulse power levels to an accuracy of ± 0.5 dB as referenced to the point of connection to the circuit under measurement. The accuracy requirement shall be met at all frequencies from 960 to 1215 MHz and at all transponder power output levels within the limits of 43 to not less than 53 dBm as referenced to the transponder antenna transmission line connector.

3.8.2.2.3 Detected rf output signal.- The power diode and its associated circuitry shall provide a video output signal at a front panel connector for use in determining pulse characteristics and for timing measurement referenced to the 50 percent voltage amplitude point on the leading edge of each rf pulse. The rf envelope reproduction and time coincidence characteristics of the output signal as displayed on the oscilloscopes

of paragraph 3.8.2.4 shall be as necessary to meet the requirements of item (5) of paragraph 3.8.1 and, when used in conjunction with the signal generator output signal of paragraph 3.6.3.7, to meet the requirements of item (12) of paragraph 3.8.1. Display of the signal shall be as required in paragraph 3.8.1.

3.8.2.3 Pulse counter.- A digital type pulse counter shall be furnished which has characteristics as necessary for the measurement and indication of all pulse rates from 0 to not less than 9999 per second with an accuracy of $\pm 0.01\%$ ± 1 count. These requirements shall be met with video signal characteristics produced by all other equipment furnished by the contractor. Means shall be provided for field calibration of the counter to the accuracy specified utilizing only the test equipment identified in the paragraphs under 3.8. A front panel control marked SENSITIVITY shall be provided to allow for input pulses within the range of 0.25 to 5 volts in amplitude. The counter shall accept either positive or negative polarity pulses.

3.8.2.4 Oscilloscope.- The requirements of 3.8.1 shall be met through use of a Tektronix Type 465 oscilloscope (not furnished under this specification). Accordingly the contractor shall demonstrate compliance with these requirements using the oscilloscope. The equipment design shall provide for mounting the specified oscilloscope toward one side of a roll-out assembly which shall also include the video test generator 3.8.2 and having a partially cut-out front panel for exposure of operating controls. When so installed, the oscilloscope front surface shall be essentially flush with the panel front surface. The design and construction shall be such that by drawing the panel unit forward on its slides all rear connections to the oscilloscope will be readily accessible from the top of the unit and the oscilloscope can be lifted off and out of the unit. The position of the unit in the cabinet shall be such that the center of the oscilloscope viewing graticule is at a height of 65 ± 3 inches above the floor.

3.8.3 RF patch panel.- Each DME shall have a test panel which provides for the interconnection between the monitor and the transponder directional couplers. Connection shall be made from the front surface of the panel by means of short patch cables furnished therewith. The following terminations shall be provided at BNC jacks located on the front panel.

- (a) The interrogation signal coupler of the transponder (3.4.9a).
- (b) The monitor reply test coupler of the transponder (3.4.9b).
- (c) The output power measurement coupler of the transponder (3.4.9c) and the input to the power diode assembly (3.8.2.2).
- (d) The rf output signal from the monitor signal generator (3.6.3).
- (e) The signal input to the monitor provided for functions other than radiated power monitoring (see 3.6.2).

3.9 Optional status indicator equipment.- The following subparagraphs describe requirements for alternate equipment to be used at facility locations depending on whether or not control cables are available for the remote monitoring of facility performance. Equipment in accordance with the requirements of these subparagraphs shall be furnished in the quantity specified in the contract schedule by reference to the appropriate option (3.9.1 or 3.9.2). (See 6.3)

3.9.1 Remote Alarm Tone Receiver.- This shall be a separate unit suitable for mounting in a standard 19 inch rack at an installation which is remote to the DME location. This receiver shall accept the 2820 Hz and/or 2940 Hz tone(s) generated by the Tone Generators in the DME cabinet (see 3.7.1.3.1.2.1). This receiver shall be capable of detecting the presence of, and distinguishing between, signals of 2820 Hz and/or 2940 Hz which will be transmitted to the unit by way of telephone line (or equivalent circuit, to be supplied by others). (See figure 4.) The remote alarm tone receiver shall meet the following requirements:

Input Response

Midpoint frequency of one audio channel shall be 2820 Hz; the other channel shall be 2940 Hz. Maximum response shall be at the midpoint frequency. Frequencies out to 15 Hz above and below the midpoint frequencies shall not be attenuated greater than 3 dB. Frequencies from 15 Hz out to 50 Hz above and below the mid-point shall not be attenuated greater than 15 dB. All frequencies separated more than 60 Hz from the midpoint frequency of each channel shall be at least 40 dB below the midpoint response.

Input Circuit

The receiver input shall be common to the two audio channels (2820 Hz-2940 Hz) by means of an electrostatically shielded transformer with a primary consisting of two balanced winding connected in series-aiding (Fig. 4). Nominal input impedance shall be 600 ohms.

Input Signals

The equipment shall meet all specified requirements with input signals of 2820 ± 15 Hz, and 2940 ± 15 Hz, at all input signals levels from -35 dBm to +6 dBm.

2820 Hz Channel

This channel shall detect the presence of 2820 Hz (within the limits set forth in Input Response, above) and provide a front panel indication of its presence. Additionally an output to a remote indicator shall be supplied to a barrier type terminal board on the rear of the receiver. This output shall operate a type NE-51 ($\frac{1}{2}$ watt) neon lamp via 300 ft. of #22 shielded, twisted pair cable in series with a 56,000 ohm resistor (NE-51 and 300 ft of wire not required to be furnished). The resistor shall be incorporated within the Remote Alarm Receiver. The front panel indicator shall be white and marked NORMAL.

2940 Hz Channel

A circuit identical to 2820 Hz Channel shall be provided for the 2940 Hz. This channel shall detect the presence of the 2940 Hz tone. The front panel indicator shall be white and marked MALFUNCTION.

Tone Channel Output Relays

The relays controlling application of power to the above indicator lamps in response to signal tones shall be sufficiently quick acting to respond to one second on-off keyed tones.

Alarm Circuit

An alarm control relay shall be provided which shall be energized when either 2820 Hz or 2940 Hz signal is applied to the input terminals. Loss of tone input shall cause the alarm switching device to de-energize after a time delay of 4 to 10 seconds (this time delay shall be adjustable and once adjusted shall be stable to ± 0.5 sec over service conditions from the adjusted value).

The alarm control switching device shall have the equivalent of two sets of form "C" contacts rated at not less than 120 VAC, 1 Amp. One set shall be wired to control the application of AC power to either a "red" or "green" front panel indicator lamp. The green lamp shall be lit when the alarm relay is energized, and the red lamp lit when de-energized (no tone input). The Green lamp shall be marked SIGNAL, and the RED lamp shall be marked ALARM. The second set of contacts, wired to the rear mounted barrier type terminal board, shall provide the identical action for two remotely located indicator lamps.

Physical Construction

The Remote Alarm Receiver shall be constructed for mounting in a standard 19 inch rack. It shall be constructed on a panel not to exceed 3 15/32 inches in height, and shall not extend greater than 14 3/4 inches behind the front panel. At the option of the contractor, the unit may be a slide out drawer assembly, or provided with a hinged front panel door. No adjustments or controls (except AC power on/off) shall be mounted on the front panel. All other features shall be in accordance with FAA-G-2300.

3.9.2 Remote radio-link status indicator equipment.- The equipment furnished hereunder shall consist of a DME signal receiver, remote indicator unit, and receiver antenna for installation at a remote location (operational control point). The receiver shall continuously monitor the presence of the DME radiated signal and also the characteristics (3.4.4) of the periodically keyed DME identification signal. Visual and aural alarms shall be provided whenever either of the following conditions exists:

- (a) the DME radiated signal is entirely absent indicating "SHUT-DOWN" or
- (b) the equalizing pulse pairs are absent from the periodically keyed identification indicating "MALFUNCTION."

Service conditions shall be as defined in paragraph 1-3.2.23 of FAA-G-2100/1 with 120 VAC (design center) input (applicable to the receiver, 3.9.2.1, only) and Environment I for the receiver and remote status unit and Environment III for the antenna.

3.9.2.1 DME signal receiver.- The receiver shall be of the fixed-tuned, crystal controlled, superheterodyne type and shall be capable of operation on any DME channel assignment (Table I) when the appropriate frequency determining crystal is installed and the mode of operation ("X" mode or "Y" mode) is manually selected. Each receiver shall be furnished with one installed crystal and one spare crystal for operation on the channel assigned for the basic DME equipment on order. It shall be possible to retune the receiver following a crystal change by utilizing only the test equipment of paragraph 3.8. Appropriate tuning controls and test jacks shall be provided (see paragraphs 3.3.12 and 3.3.15).

3.9.2.1.1 Local oscillator.- The local oscillator output frequency shall remain within 0.005% of the design center frequency for operation on the assigned channel over the range of service conditions.

3.9.2.1.2 Receiver range of acceptable input parameters.- The receiver shall be designed such as to provide no more than 3.0 dB variation in threshold alarm level when the following specified input signal parameters, in any combination, are varied over their specified ranges. These requirements shall be met over the ranges of service conditions.

- (a) Input signal frequency variation of 0.002% from nominal.
- (b) Variation of output pulse count between the limits of 700 to 5,200 pulse pairs per second.
- (c) Variation in pulse width between 2.0 and 4.0 u sec.
- (d) Variation in pulse rise and decay times each between the limits of 1.5 and 3.0 u sec.
- (e) Variation in output pulse spacings between the range of 10.5 to 13.5 u sec ("X" mode) and 28.5 to 31.5 u sec ("Y" mode).

3.9.2.1.3 Receiver rejection characteristics.- The receiver shall be designed to provide the following minimum rejections to undesired input signals:

- (a) The receiver shall provide a rejection of at least 80 dB to pulses of 0.8 μ sec duration at rf frequencies of 1030.0 \pm 0.2 MHz for any assigned DME channel frequency and occurring with spacing within the prescribed decoder acceptance range. In addition, the presence of such signal shall not change the threshold level of such signals by more than \pm 3.0 dB when the level of such signals is as high as 80 dB above the threshold level for desired signals and the number of undesired pulses is as high as 4,200 pulse pairs per second.
- (b) The rejection to DME signals on any other DME channel including the adjacent channels and at the image frequency shall be at least 80 dB.

In addition, the presence of such signals shall not change the threshold level to desired signal by more than \pm 3.0 dB when the level of such signals is as high as 80 dB above the threshold level for desired signals and the number of undesired pulses is as high as 5200 pulse pairs per second.

- (c) The presence of CW energy within the receiver bandwidth shall not result in more than \pm 3.0 dB change in the alarm level to desired DME pulsed signals when the level of such signal is 10 dB and more below the alarm level to desired signals for any setting of threshold level.
- (d) The receiver shall provide a minimum rejection of 80 dB to on-channel DME signals when the pulse spacings are 3.0 μ sec and more removed from the nominal pulse spacings (12.0 μ sec for "X" channel and 36.0 μ sec for "Y" channel).

3.9.2.1.4 Oscillator coupled output.- Oscillator, oscillator harmonics and all other spurious outputs shall not exceed a level of -80 dBm as measured at the antenna receptacle terminated in 50 ohms.

3.9.2.1.5 Stray emissions.- With the antenna receptacle capped and with the receiver mounted in an open framework rack, the effective radiated power (ERP) of all rf emissions from the equipment shall not exceed a level of -80 dBm.

3.9.2.1.6 RF input circuit.- The receiver input circuit shall be designed for use with 50 ohm unbalanced coaxial cable. The input circuit VSWR shall not exceed 2.0 over the frequency band. The input connector shall be type "N" female and shall be located on the rear of the unit chassis. A mating cable connector shall be furnished with each receiver for attachment to type RG-214/U cable. (Cable is not required to be furnished under this specification.)

3.9.2.1.7 RF input signal range.- The receiver shall be capable of operation (provide non-alarm indications) with input signal levels anywhere within the range of -85 dBm to -10 dBm. An alarm level control shall be provided in order to meet these requirements. At no setting of

the alarm level control shall it be possible to obtain a non-alarm indication when the input signal is removed completely.

3.9.2.1.8 Shutdown alarm circuit operation.- After initial adjustment with any input signal within the range of -65 dBm to -10 dBm, the receiver shall continue to provide a non-alarm indication when the level of the input signal is reduced by as much as 14 dB but shall provide an alarm indication when the signal level is reduced by 26 dB. The above requirements shall be met over the range of service conditions. Additionally, the actual alarm level point shall not vary more than ± 3.0 dB over the service conditions. For any alarm level setting the difference in input signal between alarm indication (decreasing signal level) and restoration of normal indication (decreasing signal level), shall not exceed 1.0 dB.

3.9.2.1.8.1 Alarm delay.- A delay (adjustable between 4 and 40 seconds) shall be provided between the time of occurrence of reduced input signal level below alarm level and the display of a "SHUTDOWN" alarm. Once displayed, the alarm condition shall be retained until a signal above alarm level is again present. Delay, once set, shall be stable within 0.5 seconds.

3.9.2.1.9 Malfunction alarm circuit operation.- Under all conditions for which a shutdown alarm indication (3.9.2.1.8) is not produced, the malfunction alarm circuit shall operate to provide an alarm indication in response to the absence of the identity train equalizing pulse pairs (3.4.4) on the received DME signal. The circuit shall provide an alarm output whenever the prescribed keying is not detected at least once within 75 ± 5 seconds. No alarm shall be produced if the equalizing pulse pair spacing is within 100 ± 10 μ sec and the fundamental repetition rate frequency is 1350 ± 15 Hz. An alarm shall be produced, however, if the equalizing pulse spacing is outside the limits of 100 ± 20 μ sec or the repetition rate frequency is outside the limits of 1350 ± 30 Hz. When in the alarm condition, the "malfunction" indication shall be retained until the next cycle of identification keying having the prescribed characteristics. The 75 ± 5 second time delay shall be reset upon each cycle of the prescribed keying. The "malfunction" indication shall, however, be removed during the presence of a "shutdown" indication.

3.9.2.1.10 Alarm indicators.- Each receiver shall be provided with three (3) front panel indicator lights, green for NORMAL operation, amber for MALFUNCTION, and red for SHUTDOWN. Either the red or amber light shall be illuminated to indicate alarm conditions in accordance with 3.9.2.1.7 and 3.9.2.1.8 respectively. The green light shall only be illuminated when neither the red nor amber lights are illuminated. Each receiver shall additionally provide an aural alarm indication (buzzer) with an associated loudness control and SILENCE button. Upon sensing of an alarm condition (and concurrent with the display of either a red or amber alarm light) the buzzer shall sound and shall continue to sound as long as the alarm condition persists except that the buzzer may be silenced by momentary depression of the SILENCE button. Once silenced, the aural alarm shall remain silent but shall operate again on the next subsequent alarm following restoration of normal operation. Operation of the SILENCE button

shall not affect the status of indicator lights. All indicator circuit components (lamps, buzzers, relays switches) shall operate at a DC power supply voltage not in excess of 28 volts (design center).

3.9.2.1.11 Physical Construction.- The DME signal receiver shall be constructed for mounting in a standard cabinet type relay rack. The chassis shall be designed such that its overall chassis depth (excluding connectors) behind the front panel shall not exceed 14 3/4 inches. The chassis shall mount on a front panel no larger than size "D" (6 31/32 inches). The front panel shall in all other respects conform to Drawing D-21140D of Specification FAA-G-2300 except that it shall be cut out and the unit chassis constructed for sliding into and out of the relay rack on heavy duty drawer slides consisting of roller and extension assemblies, Grant Pulley and Hardware Corp., 31-85 Whitestone Parkway, Flushing 54, New York Series SS168, SS300 or equal. The slides shall support the unit chassis and shall in turn be supported only by attachment to the front panel. The slides shall be provided with latching stops to limit the travel of the chassis to that sufficient for complete access to the unit components, and by intentional unlatching of the stop to permit complete removal of the chassis from the rack. Front panel thumbscrew or trigger operated locking devices shall also be furnished on the front panel to secure the unit in the closed position. It shall be possible to withdraw the chassis to its fullest extent without any leads or cables becoming disconnected or damaged or without the necessity of disconnecting any leads prior to withdrawal of the chassis. The leads and cables shall be so positioned that the chassis can be rolled back into the rack without interference with the movement and without damage to the leads and cables. A ground cable shall be provided to insure a positive ground between the chassis and the relay rack frame. Provided on the front panel shall be an AC power toggle switch, fuse, power indicator light and nameplate (all as defined in FAA-G-2100/1) and the status indicator lights aural alarm device, and silence button (3.9.2.1.10). The aural alarm loudness control (3.9.1.10) alarm level control (3.9.2.1.7) and tuning controls (3.9.2.1) shall be screwdriver controls accessible immediately upon withdrawing the unit on its slides. The AC power receptacle (FAA-G-2300), rf input connector (3.9.2.1.6) and terminal strip for remote alarm capability (3.9.2.1.12) shall be provided on the rear of the chassis. An AC power cord shall be provided in accordance with FAA-G-2300 except that its length shall be four (4) feet.

3.9.2.1.12 Remote alarm capability.- The status light, aural alarm and alarm silence circuits shall be brought out to terminals on the rear of the receiver unit chassis for remoting these indicators and control to the remote indicator unit (3.9.2.2). The receiver shall be capable of operating the remote indicator unit as well as its own indicators when the two units are interconnected by up to 200 feet of AWG No. 22 multi-conductor cable. (Interconnecting cable is not required to be furnished under this specification.)

3.9.2.2 Remote indicator unit.- The remote indicator unit shall be a completely enclosed metal structure not to exceed 6" x 6" x 6" in overall dimensions and designed so that (at the Government's option) it may either

be mounted in a rectangular cut-out in an operating console or simply placed on a desk, table, or bench top. For this purpose, the bottom surface shall be provided with four (4) removable rubber feet and the front surface shall be provided with a flange with eight (8) holes for console mounting. The eight (8) holes shall accommodate up to a size No. 6 screw, on a three (3) inch spacing between each pair of centered holes. Each hole shall be 3/16 inches from the edge of the flange along each side. Except for the rubber feet, there shall be no protrusions on the bottom, top, or sides of the unit to interfere with installation or removal of the unit from the console. A single removable top (or top and rear) cover shall provide ready access to all parts within the unit. Provided on the front panel shall be a set of status indicator lights (red, amber, and green) an aural alarm device, loudness control, and SILENCE button identical to those provided on the receiver unit. The lights and SILENCE button shall parallel those of the receiver. Operation of either SILENCE button shall silence both buzzers, however, the loudness of each shall be separately adjustable by means of its own control. A recessed male connector, Howard B. Jones, No. P-306-DB, or equal, shall be provided on the rear of the unit for interconnection with the receiver unit. A mating connector, Howard B. Jones, No. S-306-CCT, or equal, shall also be furnished.

3.9.2.3 DME receiver antenna.- The antenna shall be a vertically polarized half-wave dipole with a design center impedance of 50 ohms. The VSWR as measured at the output connector over the specified frequency range (Table I) shall not exceed 1.5 under normal test conditions nor 2.0 under conditions of simulated rainfall equivalent to 4 inches/hours. (The foregoing requirements may be met, at the contractor's option by the utilization of as many as four (4) antennas, each covering a 63 MHz bandwidth, in which case only the antenna type covering the DME channel assigned need be furnished). The input connector shall be type "N" female. A mating cable connector shall be furnished with each antenna for attachment to type RG-214/U cable. (See 3.9.2.1.6). The antenna shall be constructed of aluminum alloy with means for mounting atop of 1½ inch iron pipe or bolting to the side of a wooden pole. The antenna shall be protected by a radome to insure monitoring integrity under adverse weather conditions.

3.10 Optional radio link synchronized keying equipment.- The following subparagraphs describe the requirements for additional equipment intended for use at ILS facility locations where the DME equipment is located at the Glide Slope facility and landlines are not available for keying by the localizer. Equipment in accordance with the requirements of these subparagraphs shall be furnished in the quantities specified in the contract schedule by reference to this option (3.10). (See 6.3.)

3.10.1 Localizer signal receiver.- An rf receiver shall be provided to detect a radiated localizer signal having the characteristics defined in Specification FAA-E-2248b. The receiver shall operate when the localizer

signal combination of characteristics (carrier frequency, modulation components) are anywhere within the range of tolerances specified in FAA-E-2248b and when the carrier signal level at the receiver input terminals is anywhere within the range of 5 microvolts to 50 millivolts. The receiver shall be responsive to the identification keying of the localizer signal and shall provide an appropriate signal to the DME identification keyer (3.10.3) upon detection of each coded identification group transmitted. Detailed requirements shall be as follows.

3.10.1.1 Frequency range and tuning.- The receiver shall be of the fixed-tuned, crystal controlled, superheterodyne type and shall be capable of operation on any one of forty (40) ILS localizer frequencies within the range of 108.10 through 111.95 MHz inclusive when the appropriate frequency determining crystal is installed. Each receiver shall be furnished with one installed crystal and one spare crystal for operation on a frequency to be assigned by the Government. It shall be possible to retune the receiver following a crystal change by utilizing only the test equipment of paragraph 3.8. Appropriate tuning controls and test jacks shall be provided (see paragraphs 3.3.12 and 3.3.15).

3.10.1.2 Local oscillator.- The local oscillator output frequency shall remain within 0.005% of the design center frequency for operation on the assigned channel over the service conditions.

3.10.1.3 Image and IF rejection.- The image and IF rejection of the receiver shall not be less than 60 dB.

3.10.1.4 Adjacent channel rejection.- The rejection to signals 50 KHz and more removed from the assigned frequency shall be at least 60 dB.

3.10.1.5 Oscillator coupled output.- Oscillator, oscillator harmonics and all other spurious outputs shall not exceed 20 microvolts as measured at the antenna receptacle terminated in 50 ohms.

3.10.1.6 RF input circuit.- The rf input circuit shall be designed for use with 50 ohm unbalanced coaxial cable. The input circuit VSWR shall not exceed 1.5:1 over the frequency band (3.10.1.1). The input connector shall be Type "N" female. A mating cable connector shall be furnished with each receiver for attachment to Type RG-214/U cable. (Cable is not required to be furnished under this specification.)

3.10.1.7 Operating dynamic range.- After initial adjustment with any input signal within the range of 50 microvolts to 50 millivolts, the receiver shall continue to provide an output in response to ILS localizer keying when the carrier signal input level is reduced by as much as 20 dB, but shall not respond when the signal level is reduced by 40 dB. A threshold control shall be provided in order to meet these requirements. The above requirements shall be met over the equipment range of service conditions after initial adjustment of the threshold control under normal operating conditions.

3.10.1.8 Signal level differential performance.- For any threshold signal setting, the difference in input signal between failure to operate (decreasing signal level), and restoration of normal operation (increasing signal level), shall not exceed 3.0 dB.

3.10.2 Antenna.- An antenna shall be provided for operation with the localizer signal receiver (3.10.1). Detailed requirements shall be as follows.

3.10.2.1 Electrical characteristics.- The antenna shall be a horizontally polarized half-wave dipole with a design center impedance of 50 ohms. The VSWR as measured at the output connector over the specified frequency range (3.10.1.1) shall not exceed 1.25:1 under normal test conditions nor 1.5:1 under conditions of simulated rainfall equivalent to 4 inches/hour. The input connector shall be Type "N" female. A mating cable connector shall be furnished with the antenna for attachment to Type RG-214/U cable. (See 3.10.1.6).

3.10.2.2 Mechanical detail.- The antenna shall be constructed of aluminum alloy with means for mounting atop a 1½ inch iron pipe or bolting to the side of a wooden pole or steel open-framework tower.

3.10.3 DME Keyer.- When radio link synchronized keying is utilized, the identification keying switching device (3.4.4.1) shall be operated from the output of the DME keyer to be furnished integrally with the DME equipment instead of by keying pulses received by wire connection to the associated VHF facility. Detailed requirements shall be as follows.

3.10.3.1 Normal mode.- Whenever the signals received by the localizer signal receiver (3.10.1) indicate that the localizer transmitter is being keyed in accordance with the second sentence of paragraph 3.14.4.2 of Specification FAA-E-2248b ("DME position" with each fourth cycle of localizer keying omitted) the DME keyer shall operate to key the identification keying switching device (3.4.4.1) only during that period of time (fourth cycle) that keying is absent from the localizer transmitter. Synchronized keying shall thereby be accomplished as intended under paragraph 3.14.4.2 of FAA-E-2248b except that the exact dot-dash-spacing characteristics and exact time of occurrence of DME keying shall be as determined by the DME keyer instead of by the localizer keyer. Means shall be provided to adjust the time of occurrence of the identification group so that it is centered in the silent interval of the localizer keying cycle. After initial adjustment, the time of occurrence shall not vary more than 0.2 seconds over the service conditions. In the event the localizer transmitter identification keying, as sensed by the localizer signal receiver, is other than as described above (i.e., if it is either being keyed on every cycle, or is transmitting a continuous 1020 Hz identity tone, or is not being keyed at all) the DME keyer shall not operate to key the DME during the time of such abnormal operation.

3.10.3.2 Independent mode operation.- The DME keyer shall be capable of operating independently of the localizer signal receiver. When the keyer is so operated it shall provide keying of the DME at the specified

interval (3.10.3.3). This mode of operation shall be selectable by means of a manual switch provided within the DME keyer. The selector switch shall be provided with a bracket or other locking device to prevent inadvertent operation.

3.10.3.3 Electrical requirements.- The DME keyer shall provide keying pulses having the characteristics specified in paragraph 3.14.4.1 of FAA-E-2248b. The keyer shall be an electronic device employing digital techniques to generate the required pulse characteristics. Selection of any code sequence (3.14.4.1 of FAA-E-2248b) shall be capable of accomplishment within 15 minutes or less, utilizing only ordinary hand tools. When operated in the independent mode (3.10.3.2) the code sequence shall be repeated at the interval of 240 dot lengths.

3.11 Reliability and maintainability program.- All equipment furnished under this specification shall comply with requirements of MIL-STD-785 and 470 and shall provide reliability and maintainability in accordance with the requirements of the subparagraphs hereto.

3.11.1 Reliability and maintainability values.- The equipment furnished under paragraph 3.1.1, shall meet the following requirements:

- (a) A (specified) mean time between failures (MTBF) of 2500 hours for the basic equipment (3.1.1); 10,000 hours for the remote alarm tone receiver (3.1.1); and 5,000 hours for remote radio link status indicator equipment (3.9.2).
- (b) The mean time to repair (MTTR) shall be not more than 30 minutes with no more than 10% of all repairs exceeding 45 minutes and no single repair exceeding 90 minutes. (Applies to each element 3.1.1, 3.9.1 and 3.9.2.)
- (c) The mean preventive maintenance time (MPMT) shall not exceed 15 minutes in 5,000 hours of operation. (Applies to each element 3.1.1, 3.9.1 and 3.9.2.)

3.11.2 Reliability program.- The required reliability shall be obtained through a reliability program performed in accordance with MIL-STD-785 and the following:

- (a) The MIL-HDBK-217 and revisions thereto shall be utilized as required by MIL-STD-785.
- (b) The contractor shall perform an analysis of the proposed design for the equipment to determine compatibility with the required MTBF. A failure rate shall be assigned to each part of the equipment in accordance with the data presented in MIL-HDBK-217. Parts not included in the coverage of MIL-HDBK-217 shall be assumed to possess the failure rate of the most similar part in the coverage. Where this is unrealistic, any valid existing data shall be used upon the approval of the Government.

The analysis shall be submitted to the Contracting Officer. Where the predicted figure is less than the requirements, the contractor shall accomplish such changes in design as are necessary to raise the predicted MTBF to the required value.

- (c) The reliability analysis shall be revised periodically to reflect design changes and the availability of better data on part stress levels. Such revised reports shall be submitted at intervals not to exceed 90 days.
- (d) As the fabrication of each component of the equipment is completed such that all enclosures and units are in place and normal equipment operation is possible, the contractor shall prepare and submit to the Government a final prediction of the reliability of the equipment. If this prediction indicates a lesser reliability than that required, the contractor shall accomplish such changes in design, part application and part stress as are necessary to reduce the final indicated equipment failure rate to an acceptable level.

3.11.3 Maintainability program.- The required maintainability shall be achieved through a maintainability program performed in accordance with MIL-STD-470. The terms and definitions for maintainability not otherwise described or delineated herein shall be in accordance with MIL-STD-721. All electronic and mechanical equipment shall be designed and constructed to minimize skill, experience and time necessary to disassemble, assemble and maintain them. Corrective maintenance shall utilize a remove-and-replace concept with actual repair of the replaced module to be accomplished later in a separate maintenance area.

3.11.4 Reliability/maintainability design reviews.- The reliability/maintainability program shall include at least two design reviews. The first shall be a parts review to determine that all parts in the equipment have an adequate margin of safety for their respective application and functions. The second review covering electrical and mechanical aspects shall be concerned with possible circuit simplifications, accessibility of parts and assemblies for replacement and other test maintenance operations. Minutes and all relevant data of these reviews shall be documented and incorporated in the reports of paragraph 3.11.5.

3.11.5 Reliability/maintainability reports.- In accordance with the contract schedule, the contractor shall prepare and submit reliability/maintainability reports containing a complete detailed analysis of the equipment reliability and maintainability as required under this specification. The report shall be updated and submitted monthly. The results of reliability and maintainability predictions, design reviews, data collection and analysis shall serve to identify problems which limit reliability and maintainability. All design changes during the reporting period shall be identified with supporting data and computations as are relevant. The report shall include an estimate on the effect of the

design changes on reliability and maintainability. The reliability/maintainability predictions shall serve as reference values for computing the incremental effects.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- See section 1-4 of Specification FAA-G-2100/1.

4.2 Test.- Table II hereof contains a tabulation identifying design qualification, type and production tests to be accomplished.

4.2.1 Temperature and humidity testing.

4.2.1.1 Electronics system testing.- Temperature and humidity testing of the electronics equipment shall include testing with the full complement of units installed in the equipment cabinet placed in the environmental chamber. The five (5) hour time limit for the temperature rise cycle (Step 4, paragraph 1-4.12 of FAA-G-2100/1) shall not apply. In lieu thereof, the rate of temperature rise shall be reduced as required to permit the recording of all measurements and tests at each 10°C interval. The electronics system testing under temperature and humidity shall include all minimum performance and stability requirements of the transponder and monitor which do not involve change in the settings of continuously variable controls on the equipment under test. The equipment shall be inter-connected and the controls set as for normal unattended operation except for periodic substitution of simulated reply pulses to the monitor for purposes of measuring alarm threshold stabilities. During the simulation of fault conditions, the control equipment shall be prevented from initiating shut-down action. This feature, along with all other functional checks of the control equipment shall however be tested after the last recording of measurements under Steps 1, 3, 4, 6, and 8 of paragraph 1-4.12 of FAA-G-2100/1.

4.2.1.2 Supplemental unit testing.- Where demonstration of compliance with all specific performance requirements of individual units is not practicable under the system environmental test of 4.2.1.1, supplemental environmental tests shall be conducted on the individual units. Since the maximum ambient temperature specified under service conditions for the ground station equipment applies to the complete cabinet rack with equipment installed, units tested while not installed in the cabinet shall be tested at 15°C higher maximum temperature, or if the contractor can demonstrate that the average temperature within the cabinet is less than 15°C above the maximum ambient temperature surrounding the cabinet the lesser value shall be used.

4.2.1.3 Antenna testing.- For temperature and humidity testing of the antenna, the requirements of 1-4.12 of FAA-G-2100/1 are modified to delete all measurements at intermediate temperatures. After each stabilization period (-50°C, +70°C and +70°C with humidity soak) the antenna shall be removed to a reflection-free site and the measurements accomplished as rapidly as possible.

4.3 Reliability and maintainability tests.- The contractor shall demonstrate through operational tests and evaluation of the equipment that the MTBF, MTTR, and MPMT requirements of the specification are met. The tests and demonstrations shall be accomplished through actual operation of equipment for sufficient periods of time to assure that the respective requirements are met. The following requirements shall apply.

4.3.1 Organizational requirements.- A demonstration test program is a dynamic procedure that reacts to events as they occur during the test period. The contractor shall create a central test program management organization to insure that the proper test specifications are applied and that plan requirements are met. The test program management shall be responsible for overall coordination of the testing effort so as to prevent duplication and to insure that there are no omissions. The contractor's test-program management organization shall be responsible for supervising the formulation and implementation of the demonstration test plans, procedures and reporting system.

4.3.1.1 Reliability demonstration test plan.- The contractor shall design and implement a reliability test plan using MIL-STD-781, Test Plan V, with Decision Risks of 10% and a Discrimination Ratio of 3.0:1. The calendar time required for the demonstration shall be minimized. Specified MTBF is 2500 hours. (Demonstration required for basic equipment 3.1.1 only).

4.3.1.2 Maintainability demonstration test plan.- The contractor shall design and implement a maintainability demonstration plan such that the probability of the Government accepting an equipment that does not meet MTTR and MPMT requirements does not exceed 0.1. The contractor shall design plans whereunder fault simulation for corrective maintenance tasks shall be performed by the introduction of faulty parts, deliberate misalignment and "bugging" as specified in MIL-STD-471. A minimum of 50 stratified (bugged) samples are required for developing time-to-repair data. Preventive maintenance will not be charged against MTTR. Further the contractor may assume that time-to-repair data will not include logistic delay, i.e., maintenance personnel, parts and tools are available at the site. The contractor shall demonstrate MTTR (corrective maintenance) by applying Method 4 (90 percent confidence) from MIL-STD-471 using the fault simulation time-to-repair data.

4.3.2 Documentation.- The contractor shall document the formulation and implementation phases of the demonstration test plan program in accordance with the requirements hereunder. The documentation shall include data record forms and shall be complete in all relevant detail. The documentation shall be submitted to the Government for approval.

4.3.2.1 Documentation required for the formulation phase.- Documentation for the formulation phase shall include the following:

- (a) The contractor's proposed demonstration plan management organization.
- (b) A complete description of the demonstration test plans, analytic models and reliability analysis.
- (c) A complete description of the data reporting system with a description and samples of data reporting forms.
- (d) A milestone chart and planned work schedule indicating the time required to demonstrate the various phases of the demonstration requirements.

4.3.2.2 Documentation required for implementation phases.- Documentation for this phase shall consist of the following:

- (a) Progress reports are to be submitted at bi-monthly intervals with milestone charts showing the planned work schedule and work completed. The contractor's demonstration plan management must ensure that these reports are consistent with the objectives and plans described in the Formulation Phase of the demonstration test program.
- (b) Final report covering the completed contract shall contain as minimum:
 - 1. Data collected.
 - 2. Factors which influence data.
 - 3. Analysis of the data (data reduction technique used, use of the data by the analytic models).
 - 4. Results of the demonstration.

4.3.3 Failure to meet reliability/maintainability test requirements.-

The reliability and maintainability test requirements shall be considered satisfied only when the demonstration test program establishes that all requirements under paragraph 3.11 have been met. Failure to meet the respective reliability/maintainability values of paragraph 3.11.1 shall require corrective action by the contractor, at no additional cost to the Government, and restart from zero time of those demonstration tests, i.e., MTBF, MTTR, and MPMT, for which compliance was not established as a result of previous tests under the demonstration program. However, in the event corrective actions effect reliability/maintainability requirements satisfied under previous tests, the contractor shall, at no additional cost to the Government, upon written request from the Government, repeat those demonstration tests so effected.

5. PREPARATION FOR DELIVERY.

5.1 General.- See FAA-G-2100/1, paragraph 1-5.1.

6. NOTES.

6.1 Notes on information items.- The contents of this section are only for the information of the initiator of the procurement request, and are not a part of the requirements of this specification. They are not contract requirements, nor binding on either the Government or the contractor. In order for these terms to become a part of a resulting contract, they must be specifically incorporated in the schedule of the contract. Any reliance placed by the contractor on the information contained in these subparagraphs is wholly at the contractor's own risk.

6.2 Government furnished equipment.- Usage of the equipment in the field requires an oscilloscope at each location. The oscilloscope is not furnished under this specification. Consideration should be given to the possibility of furnishing, as GFE, one such oscilloscope for delivery with each DME system on order.

6.3 Options.- In addition to specifying the number of sets of each basic equipment to be furnished, (3.1.1), the contract should also specify the number to be furnished with Remote Alarm Tone Receiver (3.9.1) and the number to be furnished with Remote Radio-link Status Indicators (3.9.2). Option 3.10 is intended for use at those ILS locations where the DME is located at the Glide Slope and where landlines will not be available for keying of the DME by the Localizer equipment. Also, the method of Reliability/Maintainability testing should be incorporated in the contract requirements (see para. 3.1.6).

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TABLE I - DME CHANNEL FREQUENCIES

Channel No.	Interrogation Frequency Mhz	Reply Frequency MHz	Channel No.	Interrogation Frequency MHz	Reply Frequency MHz
17X	1041	978	39X	1063	1000
17Y	1041	1104	39Y	1063	1126
18X	1042	979	40X	1064	1001
18Y	1042	1105	40Y	1064	1127
19X	1043	980	41X	1065	1002
19Y	1043	1106	41Y	1065	1128
20X	1044	981	42X	1066	1003
20Y	1044	1107	42Y	1066	1129
21X	1045	982	43X	1067	1004
21Y	1045	1108	43Y	1067	1130
22X	1046	983	44X	1068	1005
22Y	1046	1109	44Y	1068	1131
23X	1047	984	45X	1069	1006
23Y	1047	1110	45Y	1069	1132
24X	1048	985	46X	1070	1007
24Y	1048	1111	46Y	1070	1133
25X	1049	986	47X	1071	1008
25Y	1049	1112	47Y	1071	1134
26X	1050	987	48X	1072	1009
26Y	1050	1113	48Y	1072	1135
27X	1051	988	49X	1073	1010
27Y	1051	1114	49Y	1073	1136
28X	1052	989	50X	1074	1011
28Y	1052	1115	50Y	1074	1137
29X	1053	990	51X	1075	1012
29Y	1053	1116	51Y	1075	1138
30X	1054	991	52X	1076	1013
30Y	1054	1117	52Y	1076	1139
31X	1055	992	53X	1077	1014
31Y	1055	1118	53Y	1077	1140
32X	1056	993	54X	1078	1015
32Y	1056	1119	54Y	1078	1141
33X	1057	994	55X	1079	1016
33Y	1057	1120	55Y	1079	1142
34X	1058	995	56X	1080	1017
34Y	1058	1121	56Y	1080	1143
35X	1059	996	57X	1081	1018
35Y	1059	1122	57Y	1081	1144
36X	1060	997	58X	1082	1019
36Y	1060	1123	58Y	1082	1145
37X	1061	998	59X	1083	1020
37Y	1061	1124	59Y	1083	1146
38X	1062	999	60X	1084	1021
38Y	1062	1125	60Y	1084	1147

TABLE I - DME CHANNEL FREQUENCIES

<u>Channel No.</u>	<u>Interrogation Frequency MHz</u>	<u>Reply Frequency MHz</u>	<u>Channel No.</u>	<u>Interrogation Frequency MHz</u>	<u>Reply Frequency MHz</u>
61X	1085	1022	83X	1107	1170
61Y	1085	1148	83Y	1107	1044
62X	1086	1023	84X	1108	1171
62Y	1086	1149	84Y	1108	1045
63X	1087	1024	85X	1109	1172
63Y	1087	1150	85Y	1109	1046
64X	1088	1151	86X	1110	1173
64Y	1088	1025	86Y	1110	1047
65X	1089	1152	87X	1111	1174
65Y	1089	1026	87Y	1111	1048
66X	1090	1153	88X	1112	1175
66Y	1090	1027	88Y	1112	1049
67X	1091	1154	89X	1113	1176
67Y	1091	1028	89Y	1113	1050
68X	1092	1155	90X	1114	1177
68Y	1092	1029	90Y	1114	1051
69X	1093	1156	91X	1115	1178
69Y	1093	1030	91Y	1115	1052
70X	1094	1157	92X	1116	1179
70Y	1094	1031	92Y	1116	1053
71X	1095	1158	93X	1117	1180
71Y	1095	1032	93Y	1117	1054
72X	1096	1159	94X	1118	1181
72Y	1096	1033	94Y	1118	1055
73X	1097	1160	95X	1119	1182
73Y	1097	1034	95Y	1119	1056
74X	1098	1161	96X	1120	1183
74Y	1098	1035	96Y	1120	1057
75X	1099	1162	97X	1121	1184
75Y	1099	1036	97Y	1121	1058
76X	1100	1163	98X	1122	1185
76Y	1100	1037	98Y	1122	1059
77X	1101	1164	99X	1123	1186
77Y	1101	1038	99Y	1123	1060
78X	1102	1165	100X	1124	1187
78Y	1102	1039	100Y	1124	1061
79X	1103	1166	101X	1125	1188
79Y	1103	1040	101Y	1125	1062
80X	1104	1167	102X	1126	1189
80Y	1104	1041	102Y	1126	1063
81X	1105	1168	103X	1127	1190
81Y	1105	1042	103Y	1127	1064
82X	1106	1169	104X	1128	1191
82Y	1106	1043	104Y	1128	1065

TABLE I - DME CHANNEL FREQUENCIES

<u>Channel No.</u>	<u>Interrogation Frequency MHz</u>	<u>Reply Frequency MHz</u>	<u>Channel No.</u>	<u>Interrogation Frequency MHz</u>	<u>Reply Frequency MHz</u>
105X	1129	1192	116X	1140	1203
105Y	1129	1066	116Y	1140	1077
106X	1130	1193	117X	1141	1204
106Y	1130	1067	117Y	1141	1078
107X	1131	1194	118X	1142	1205
107Y	1131	1068	118Y	1142	1079
108X	1132	1195	119X	1143	1206
108Y	1132	1069	119Y	1143	1080
109X	1133	1196	120X	1144	1207
109Y	1133	1070	120Y	1144	1081
110X	1134	1197	121X	1145	1208
110Y	1134	1071	121Y	1145	1082
111X	1135	1198	122X	1146	1209
111Y	1135	1072	122Y	1146	1083
112X	1136	1199	123X	1147	1210
112Y	1136	1073	123Y	1147	1084
113X	1137	1200	124X	1148	1211
113Y	1137	1074	124Y	1148	1085
114X	1138	1201	125X	1149	1212
114Y	1138	1075	125Y	1149	1086
115X	1139	1202	126X	1150	1213
115Y	1139	1076	126Y	1150	1087

TABLE II

(a) Design qualification tests under normal test conditions.

<u>Test</u>	<u>Paragraph</u>
Cross-talk, shielding and isolation	3.3.7
Gain, selectivity and bandpass	3.3.8
Parts protection	3.3.13
Receiver decoder (with combination of interrogation signal characteristics)	3.4.3.3
Interference suppression	3.4.3.9
Output pulse distribution	3.4.3.11
Identification keying control circuit	3.4.4.1
Tuning and spurious output	3.4.5.1
Transponder output signals	3.4.7
Spurious output	3.4.7.7
Inter-pulse output level	3.4.7.8
Polarization (4 frequencies)	3.5.4
Vertical pattern (4 frequencies)	3.5.7
Horizontal pattern (4 frequencies)	3.5.8
Monitor fail-safe operation	3.6
RF envelope detector linearity	3.6.3.7 & 3.8.1.(1)
Spurious output	3.6.3.9
Signal generator output dial linearity	3.6.3.12
Control equipment fail-safe operation	3.7
RF pulse envelope characteristics	3.8.1(5) & 3.8.2.2.3
Accuracy of reply delay measurement	3.8.1.(12)
Oscilloscope requirements	3.8.2.4
Remote alarm tone receiver	3.9.1
DME signal receiver	3.9.2.1
Stray emissions	3.9.2.1.5
RF input circuit	3.9.2.1.6
Remote alarm capability	3.9.2.1.12
DME receiver antenna VSWR under simulated rain	3.9.2.3
Frequency range and tuning	3.10.1.1
RF input circuit	3.10.1.6
Antenna VSWR under simulated rain	3.10.2.1

(b) Design qualification tests under the environmental service conditions.

(Antenna)- Design qualification tests for the antenna shall include the performance of the specified tests before and after subjecting the antenna, (in a non-operating condition) to:

<u>Condition</u>	<u>Parameter</u>	<u>Paragraph</u>
Temperature and humidity (4.2.1.3)	VSWR, gain, and coupling factor (one frequency)	3.5.5, 3.5.6, and 3.5.12
Weatherproofing (3.5.9) (simulated rain)	VSWR, gain, and coupling factor (one frequency)	3.5.5, 3.5.6, and 3.5.12
Vibration (3.5.11)	All characteristics (one frequency)	3.5.4 through 3.5.8, & 3.5.12

- (c) Design qualification tests under the service conditions of line voltage variation.- The following tests shall be performed on the operating equipment at line voltage levels of 102 VAC and at 136 VAC after initial adjustment at the normal condition line voltage (otherwise normal test conditions).

<u>Test</u>	<u>Paragraph</u>
Frequency accuracy	3.4.1.1
Receiver decoder	3.4.3.3
Receiver dead time	3.4.3.4
Receiver sensitivity	3.4.3.7.1 thru 3.4.3.7.1.2
Reply efficiency	3.4.3.8
Receiver noise output stability	3.4.3.11
Automatic gain reduction	3.4.3.12
Priority	3.4.3.13
Identification signal	3.4.4
Output pulse characteristics	3.4.7.1 thru 3.4.7.1.4
Pulse coding	3.4.7.2
Reply delay variation	3.4.7.3
Transponder power output	3.4.7.4
Pulse power variation	3.4.7.5
RF pulse signal spectrum	3.4.7.6
Frequency accuracy	3.6.1.1
Signal Generator output pulse characteristics	3.6.3.4
Pulse coding	3.6.3.5
Pulse power variation	3.6.3.6
RF output level	3.6.3.12
Alarm delay time	3.6.4.1.1
Reply efficiency monitoring	3.6.4.2
Reply delay monitoring	3.6.4.3
Spacing monitor	3.6.4.4
Pulse rate monitor	3.6.4.5
Power output monitoring	3.6.4.6
Identification signal monitoring	3.6.4.7
Control unit	3.7.1.1.1 thru 3.7.1.7

Performance test and measurement capability	3.8.1
Video test generator	3.8.2.1
Power diode calibration	3.8.2.2.2
Pulse counter	3.8.2.3
Remote alarm tone receiver	3.9.1
Local oscillator	3.9.2.1.1
Receiver range of acceptable input parameters	3.9.2.1.2
Shutdown alarm circuit operation	3.9.2.1.8
Alarm delay	3.9.2.1.8.1
Local oscillator	3.10.1.2
Operating dynamic range	3.10.1.7

(d) Type tests under the service conditions of temperature and humidity (1-4.3.3.2 of FAA-G-2100.-

<u>Test</u>	<u>Paragraph</u>
Assigned channel frequency, accuracy and stability	3.4.1.1
Receiver bandwidth and stability	3.4.3.2
Receiver decoder	3.4.3.3
Receiver dead time	3.4.3.4
Receiver sensitivity variation with loading	3.4.3.7.1
Receiver sensitivity	3.4.3.7.1.1
Sensitivity at other pulse spacings	3.4.3.7.1.2
Adjacent channel rejection	3.4.3.7.2
Reply efficiency	3.4.3.8
Receiver noise output stability (random pulses)	3.4.3.10
Output pulse rate control	3.4.3.11
Automatic gain reduction	3.4.3.12
Priority	3.4.3.13
Identification signal	3.4.4
Pulse shape	3.4.7.1 et seq.
Pulse coding	3.4.7.2
Reply delay variation	3.4.7.3
Power output	3.4.7.4
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Pulse coding	3.6.3.5
Pulse power variation	3.6.3.6
Test rf output frequencies	3.6.3.10
RF output level	3.6.3.12
Alarm delay time	3.6.4.1.1
Monitor response time	3.6.4.1.2
Reply efficiency monitoring	3.6.4.2
Reply delay monitoring	3.6.4.3

Pulse spacing monitoring	3.6.4.4
Transponder pulse rate monitoring	3.6.4.5
Transponder power output monitoring	3.6.4.6
Identification signal monitoring	3.6.4.7
Control unit	3.7.1.1.1 thru 3.7.1.7
Video test generator	3.8.2.1
Power measurement accuracy	3.8.2.2.2
Pulse counter	3.8.2.3
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Signal level differential performance	3.10.1.8
Normal mode	3.10.3.1

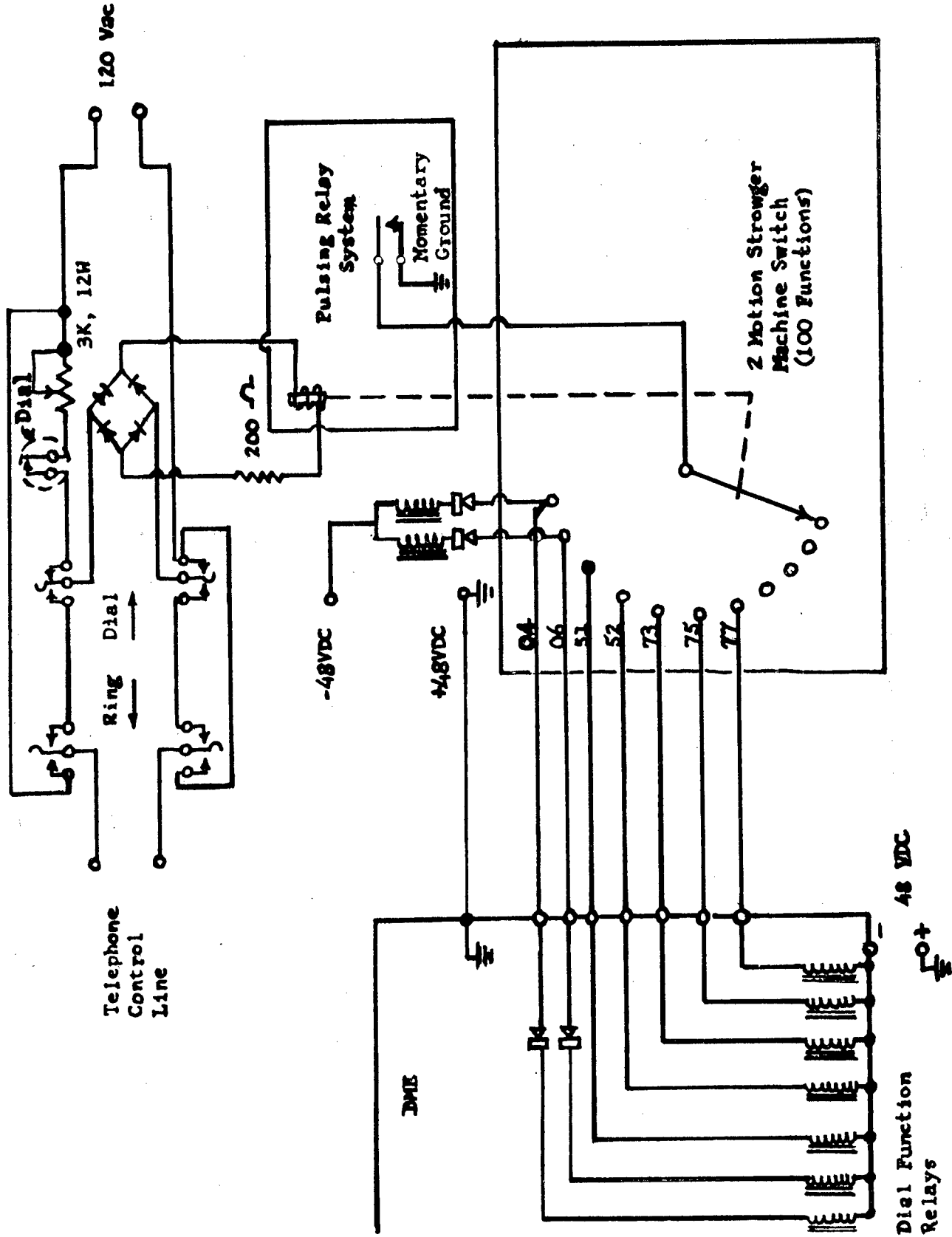
(e) Type tests under normal test conditions.

<u>Test</u>	<u>Paragraph</u>
Transponder tuning range ("X" and "Y" channels)	3.4.1
Duplexer tuning range ("X" and "Y" channels)	3.4.2
Receiver recovery line	3.4.3.5
Echo suppression	3.4.3.6
Desensitization by adjacent channel interrogation	3.4.3.7.1.3
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Localizer signal receiver	3.10.1
Image and IF rejection	3.10.1.3
Adjacent channel rejection	3.10.1.4
Oscillator coupled output	3.10.1.5
Antenna VSWR (three frequencies)	3.10.2.1

(f) Production tests.- The following tests shall be made on the assigned channel rf frequency unless otherwise specified.

<u>Test</u>	<u>Paragraph</u>
Directional couplers	3.3.9
Frequency accuracy	3.4.1.1
Receiver decoder	3.4.3.3
Receiver dead time	3.4.3.4
Echo suppression (range of adjustment)	3.4.3.6.2
Receiver sensitivity	3.4.3.7.1
Receiver sensitivity	3.4.3.7.1.1
Sensitivity at other pulse spacings	3.4.3.7.1.2
Adjacent channel rejection	3.4.3.7.2
Reply efficiency	3.4.3.8
Receiver noise output range of adjustment	3.4.3.10
Automatic gain reduction	3.4.3.12
Priority	3.4.3.13
Identification signal	3.4.4
Identity keying control switch	3.4.4.2
RF output control	3.4.5.2
Reply delay adjustment	3.4.5.3
Local high voltage control switch	3.4.6.1
Operation of overload protective devices	3.4.6.2
Pulse shape	3.4.7.1 et seq.
Pulse coding	3.4.7.2
Reply delay variation	3.4.7.3
Power output	3.4.7.4
Pulse power variation	3.4.7.5
RF pulse spectrum	3.4.7.6
VSWR (4 incremental frequencies across band)	3.5.5
Monitor probe coupling factor (4 frequencies)	3.5.12
Frequency accuracy	3.6.1.1
Operational modes	3.6.3.1
Trigger out pulse	3.6.3.2
Timing reference pulse	3.6.3.3
RF output pulse signal characteristics	3.6.3.4
Pulse coding	3.6.3.5
Pulse power variation	3.6.3.6
Test rf output frequencies	3.6.3.10
RF output level calibration	3.6.3.12
Monitor input level range	3.6.4
Alarm delay time	3.6.4.1.1.
Reply efficiency monitoring	3.6.4.2
Reply delay monitoring	3.6.4.3
Spacing monitor	3.6.4.4
Pulse rate monitor	3.6.4.5
Power output monitoring	3.6.4.6
Identification signal monitoring	3.6.4.7
Control unit	3.7.1.1. thru 3.7.1.7

Test equipment operational check	3.8.1
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Power diode VSWR (4 frequencies)	3.8.2.2.1
Power diode calibration	3.8.2.2.2
Pulse counter	3.8.2.3
Remote alarm tone receiver	3.9.1
RF input signal range	3.9.2.1.7
Shutdown alarm circuit operation	3.9.2.1.8
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Malfunction alarm circuit operation	3.9.2.1.9
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REPLACES THE PREVIOUS EDITIONS OF THE FACILITY CONTROL SYSTEM

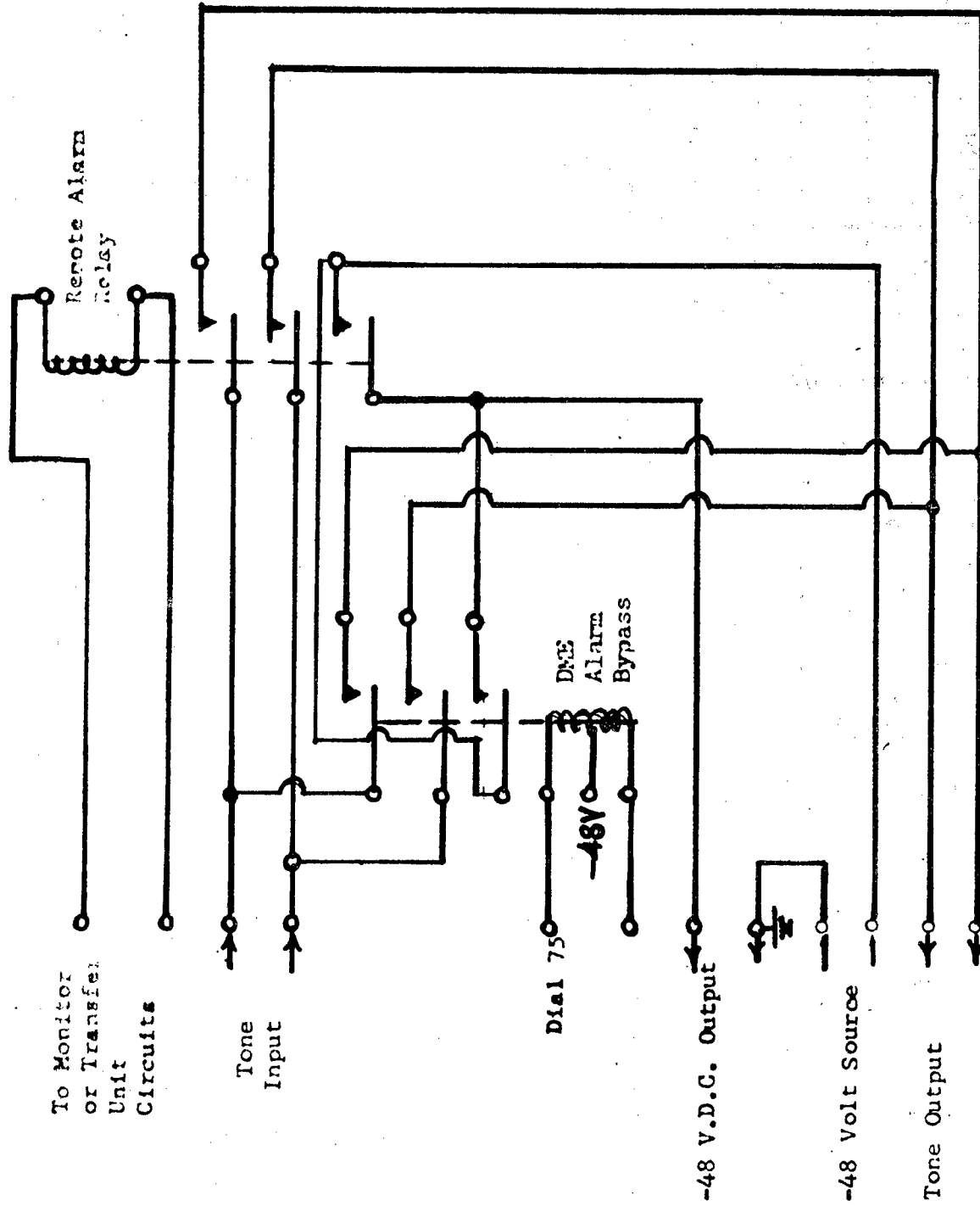


FIGURE 2 FUNCTIONAL DIAGRAM OF REMOTE ALARM SIGNAL CONTROL CIRCUITRY

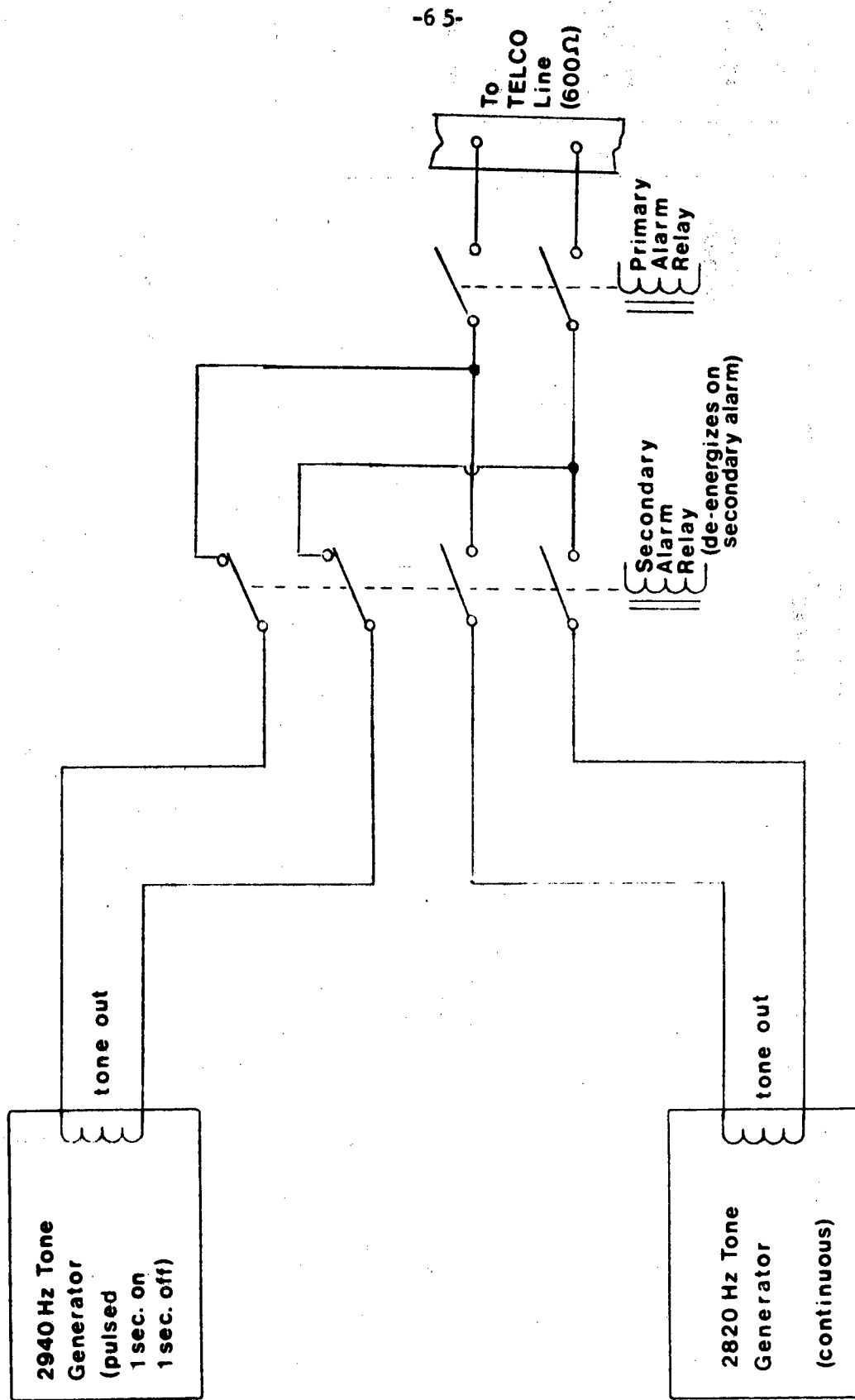


FIGURE 3. Functional Diagram of Tone Generators

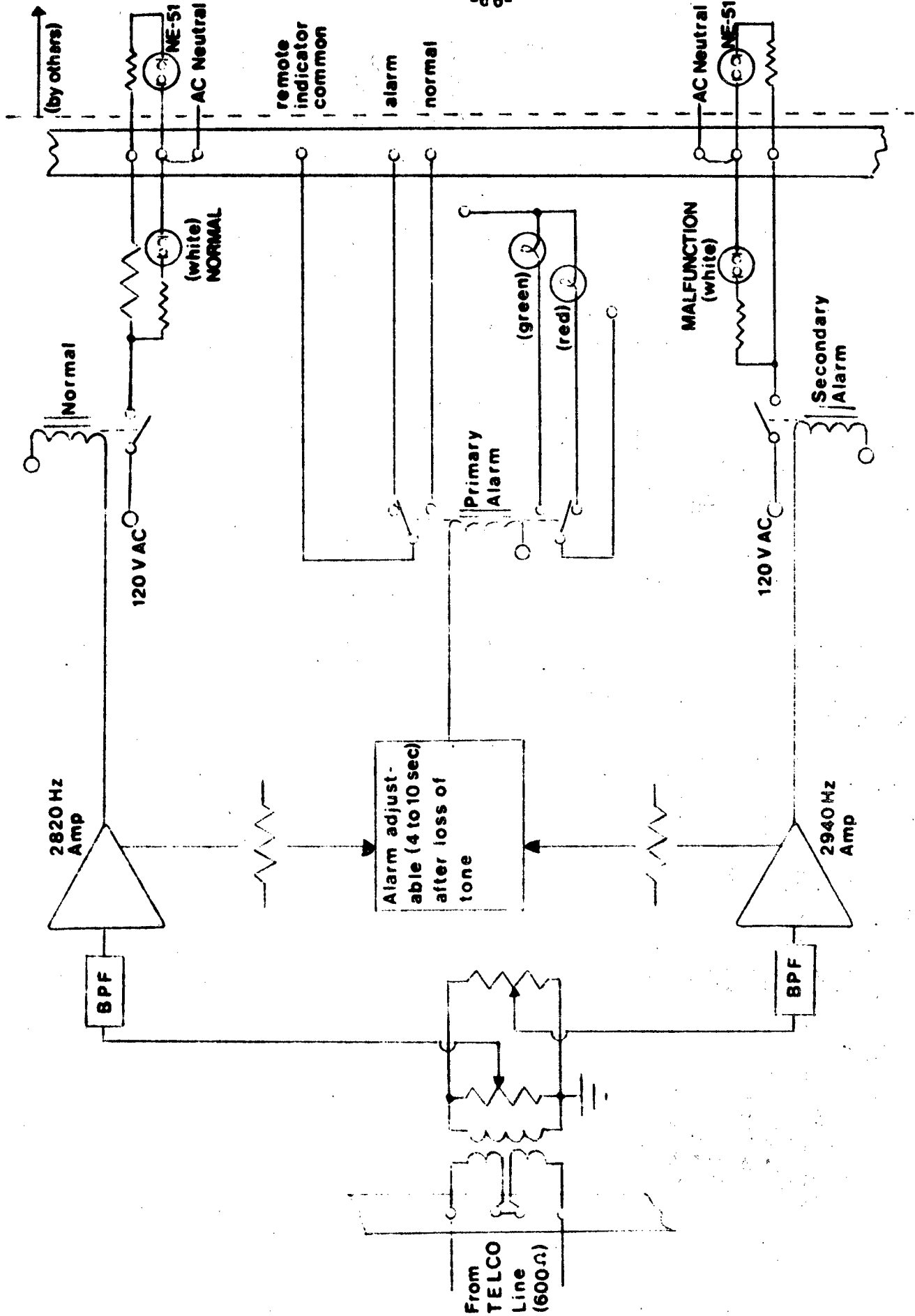


FIGURE 4. Functional Diagram of Remote Alarm Receiver

SUPERSEDING FAA-E-2444,
8/28/70
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DME GROUND STATION EQUIPMENT, TERMINAL AREA

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FIGURE 1. Functional Diagram of Facility Control Circuitry.

FIGURE 2. Functional Diagram of Remote Alarm Signal Control Circuitry.

FIGURE 3. Functional Diagram of Tone Generators.

FIGURE 4. Functional Diagram of Remote Alarm Receiver.

DME GROUND STATION EQUIPMENT, TERMINAL AREA

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